SOUTH SHORE OF STATEN ISLAND, NEW YORK
COASTAL STORM RISK MANAGEMENT

FINAL VALIDATION REPORT

JANUARY 2024

Executive Summary

Introduction

The Coastal Storm Risk Management project for South Shore Staten Island (SSSI), New York, is in the pre-construction, engineering, and design phase. The Director's Report for SSSI was signed on October 27, 2016. The approved Feasibility Report culminated in a Director's Report (2016) because the study was Sandy funded to completion and nourishment was not anticipated for the project. The Director's Report authorized, subject to the approval of the Assistant Secretary of the Army for Civil Works, the use of funding from the Hurricane Sandy Disaster Relief Appropriation Action ("Sandy Program") (P.L. 113-2) for construction of the project. The Project Partnership Agreement was executed on February 15, 2019 with the non-federal sponsor, the New York State Department of Environmental Conservation (NYSDEC) and the City of New York, a limited Party to the Agreement and a local sponsor to the NYSDEC. This Validation Report documents updates to the authorized project, necessitated by refined modeling and incorporation of geotechnical data that were not available during the study phase. The Validation Report has been prepared because it is anticipated that the updated implementation costs will exceed the funding available under the above referenced Sandy Program, and to support a request to Congress for Construction General funding to complete construction. This report explains the causes of the cost changes relating to the design updates for the seawall feature from Fort Wadsworth to Oakwood Beach. It also presents updated benefits that demonstrate the project remains economically justified, validates the seawall as the authorized project, and serves as the basis for modification to the existing project authorization.

Purpose and Need

Flooding from Hurricane Sandy caused widespread damage and destruction on the South Shore of Staten Island. As a result of Hurricane Sandy, residences, businesses and cars were heavily damaged and whole blocks of homes were removed from their foundations[1]. Reported damages in the U.S from Hurricane Sandy are upwards of $50 Billion, making it the second costliest storm in U.S. history since 1900[2]. The event continues to have lasting economic, social, and personal effects[3].

The resulting damages to people, property and loss of life exemplify the critical need for improvements to coastal storm risk management in the region.

Life Safety and Environmental Justice

Although the project is justified based upon NED benefits, the project also contributes to life safety and addresses storm risk in socially vulnerable communities. Fourteen of the twenty-three lives lost recorded for Staten Island were directly due to Hurricane Sandy flooding. Remaining mortality counts occurred in situations where storm forces indirectly led to unsafe conditions (e.g., hazardous roads) or caused a loss or disruption of usual services (e.g., loss of electrical services)[4]. The project will significantly reduce the risk to life-safety. The study area also contains neighborhoods containing socially vulnerable populations for whom it is more difficult to prepare for and respond to coastal flood events. It has been documented that the impacts of hazard exposure often fall disproportionately on the most vulnerable people in a

[1] Eric S. Blake, et al (2013). Tropical Cyclone Report, Hurricane Sandy. Miami: National Hurricane Center.

[2] Eric S. Blake, E. J. (2011). The Deadliest, Costliest, and Most Intense United States Tropical Cyclones from 1851 to 2010. Miami: National Weather Service.

[3] New York City Department of Planning (2017). Resilient Neighborhoods, East Shore, Staten Island

[4] Morbidity and Mortality Weekly Report (MMWR), Dated May 24, 2013, "Deaths Associated with Hurricane Sandy — October–November 2012", Center for Disease Control

society—the poor, minorities, children, the elderly, and the disabled. The limitations these populations face impacts their ability to take timely protective action when a coastal storm hits. The recommended project will provide coastal storm risk reduction to these communities in the study area.

Summary of Design Updates

The Director's Report (2016) recommended construction of an armored stone seawall (buried rock seawall), floodwall, and earthen levee to extend 5.3 miles from Fort Wadsworth to Oakwood Beach with a crest elevation of +19.4 ft North American Vertical Datum of 1988 (NAVD88) to address coastal storms that produce a stillwater level (SWL) up to 14.5 feet NAVD 88, (which was equivalent to a 0.33% Annual Exceedance Probability (AEP) SWL under the USACE low scenario.[5] Based on updated coastal modeling, the seawall crest elevation needs to be increased to +21.4 ft NAVD88 to meet the selected wave overtopping threshold for the design water level. To minimize the cost increase while meeting the intent of the authorization, the construction method of a double sheet pile wall is recommended instead of the buried rock seawall. Doing so closely maintains the project footprint and limits the cost increases. An economic comparison of the annual costs and benefits provides the basis for a decision as to whether the recommended plan is a feasible Coastal Storm Risk Management Solution in line with the authorized plan. Note that while the Validation Study focuses on seawall design changes and the associated costs, there were other design refinements made during the design phase resulting in additional costs being added to the Project First Cost. Net NED annualized benefits are $8,392,000 (intermediate relative sea level change (RSLC) scenario) and certified annualized costs (FY24) are $80,883,000 and the benefit-to-cost ratio is 1.1. The recommended changes meet planning objectives, and the project remains economically justified.

Recommendations

Within the study area, there are over 7,300 structures and over 30,000 people. Of these structures approximately 4,600 lie within the 1% floodplain[6] with approximately 21,000 people at risk of the impacts hurricane storm forces without a project. This validation report recommends the following adjustments to the design of the authorized plan: 1) use double sheet pile seawall section rather than buried rock seawall section, and 2) increase the project height from +19.4 ft NAVD88 to +21.4 ft NAVD88. The recommended changes will reduce the risk of impacts to people and structures from extreme coastal storms while minimizing necessary cost increases to the project. Costs for the authorized project were $571 million (Fiscal Year 2017 (FY17), adjusted to $807 million in FY24 price levels). The designs and assumptions supporting the FY17 estimate are no longer viable. With updated designs and unit costs, the estimated first cost of the recommended plan is $2,094,202,000 (FY24)[7]. The recommended modifications are economically justified at the intermediate rate of RSLC and exceed the benefits of other alternatives studied to provide risk management to the community.

[5] The earthen levee is set back from the shoreline and is designed to elevation +16.9 ft NAVD88.

[6] The number of structures and population at risk is based on the effective 1% FEMA floodplain documented in the Director's Report.

[7] Includes expended cost.

Pertinent Data

General

This validation report documents refinements to the authorized SSSI project. As part of the preconstruction design process, updates were made to the authorized plan to provide performance capabilities of the feasibility design based on availability of updated site data. These include increasing the seawall height from +19.4 ft NAVD88 to +21.4 ft NAVD88 and modifying the seawall design from a buried rock seawall cross-section to a double sheet pile wall cross-section. The project delivery team developed cost estimates using quantities of time and materials to make reasonable comparisons between the authorized project recommended in the Director's Report and the recommended changes from this validation effort. Costs are based on a 10% design level for the seawall contracts, which represent approximately 80% of the total project costs. It should be noted that the 10% level of design for the seawall is informed by physical modeling and new geotechnical analyses. Level of design for other contracts, including the levee and floodwall reaches and interior drainage areas, ranges from 30% to 100%.

The economic analysis updates the structure inventory from 2016, when the Director's Report was signed, and also updates water surface profiles and wave data. The current analysis draws on Coastal Hazards System (CHS) data developed as part of the North Atlantic Coast Comprehensive Study (NACCS), which were used for engineering evaluations. For consistency, NACCS still water[8] elevations and waves were used for damage estimation instead of the Federal Emergency Management Agency (FEMA) data that was used in the feasibility phase. This validation report highlights the updates from the feasibility phase to the design phase. Per ER 1100-2-8162, the BCRs are reported for all three RSLC scenarios, as directed. However, it should be noted that the latest tide gauge observations indicate that the SSSI project area sea level change rates are tracking above the low scenario and are tracking between the intermediate and high scenarios of RSLC. Therefore, the intermediate scenario is used in this report to present expected economic performance of the project.

[8] Stillwater refers to flood levels without wave effects

*Table 1 Project Economics**

Director's Report (FY17)			
RSLC Scenario	Low**	Intermediate	High
Project First Cost	$571,252,000	$571,252,000	$571,252,000
Total Project Cost	$615,231,000	$615,231,000	$615,231,000
Average Annualized Cost	$23,458,000	$23,458,000	$23,458,000
Average Annualized Benefits	$30,374,000	$32,418,000	$38,125,000
Net Benefits	$6,916,000	$8,960,000	$14,667,000
Benefit to Cost Ratio	1.3	1.4	1.6
Validation Report (FY24)			
RSLC Scenario	Low	Intermediate	High
Project First Cost***	$2,094,202,000	$2,094,202,000	$2,094,202,000
Total Project Cost****	$2,330,751,000	$2,330,751,000	$2,330,751,000
Average Annualized Cost	$80,883,000	$80,883,000	$80,883,000
Average Annualized Benefits	$67,491,000	$89,275,000	$204,583,000
Net Benefits	($13,392,000)	$8,392,000	$123,700,000
Benefit to Cost Ratio	0.8	1.1	2.5

* The Feasibility Low Scenario is the 19.4ft NAVD plan evaluated in October 2016 price levels and federal discount rate of 2.875% using FEMA coastal water levels whereas the Validation Low Scenario is the 21.4ft NAVD88 plan evaluated in FY24 price levels and federal discount rate of 2.75% using NACCS water levels. Values are rounded to the nearest 1,000s. See Section 10 of this report for details of benefits update.

** Per ER 1100-2-8162, the BCRs are reported for all three RSLC scenarios, as directed. However, it should be noted that the latest tide gauge observations indicate that the RSLC in the SSSI project area is tracking at a rate between the intermediate and high scenarios of RSLC. The intermediate scenario or the high scenario are the best indicators of expected economic performance, and the results for the intermediate rate of RSLC are used in presenting results for this report.

***Project first costs include expended costs to date

***** Midpoint of construction for Total Project Cost is Q3 FY2028

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(1) Description of Authorized Project.

The authorized project for the South Shore of Staten Island runs from Fort Wadsworth to Oakwood Beach, consisting of a buried seawall, floodwall, earthen levee, road raising, road closure structure, and associated interior drainage features. The project acts as the first line of defense against storm surge flooding and wave forces and reduces the risk of storm damage. The feasibility study was completed and approved in 2016 using funds provided through the American Recovery and Reinvestment Act of 2009 and the Disaster Relief Appropriations Act of 2013 (P.L. 113-2).

The authorized plan was selected based on the following plan formulation objectives, constraints, and considerations from the feasibility phase:

Planning objectives from the feasibility phase, as documented in the Director's Report (2016) are to:

- Manage the risk of damages from storm surge flooding, caused by coastal storms such as nor'easters, tropical storms and hurricanes, for the study area.
- Manage the risk to local residents' life and safety.
- Manage the residual flood damage from rainfall events.

Constraints are:

- Plan must avoid or minimize environmental impacts to the maximum degree practicable.
- Average annual benefits must exceed the average annual costs.
- Plans shall represent sound, safe, and acceptable engineering solutions taking into account the overall littoral system effects.
- Plans shall be designed to be low maintenance.
- Plans should avoid or minimize impacts to environmental resources with the potential for enhancement.
- Plans shall not affect public access of the beach.
- Plans shall take into consideration aesthetics and viewshed.
- Plans shall be in compliance with USACE regulations.

Considerations are:

1. Plans must be efficient, make optimal use of resources, and not adversely affect other economic systems.
2. Plans must incorporate Environmental Operating Principles.
3. All reasonable opportunities for development within the project scope must be weighed, with consideration of state and local interests.
4. The needs of other regions must be considered, and one area cannot be favored to the detriment of another.
5. Plans must maintain existing cultural resources to the maximum degree possible and produce the least possible disturbance to the community.
6. Plans must be consistent with existing federal, state, and local laws.
7. Plans must be locally supported and signed by local authorities in the form of a Project Partnership Agreement and guarantee for all items of local cooperation including possible cost sharing.
8. Local interests must agree to provide public access to the shore in accordance with federal and state guidelines and laws.
9. The plan must have overall support in the region and state.
10. The impacts to beach erosion as a result of the implementation of the project must be considered during plan formulation and selection.
11. Develop a plan consistent with and complementary to the New York City Bluebelt Program and recreational use of the area.

12. Where possible, plans will utilize the properties and easements available through the City, State, and federal Government, or properties previously approved by NYC for acquisition under the Bluebelt Program. This will avoid delays associated with the Sponsor's land acquisition review process.

Description of Authorized Project

Per the Director's Report, signed October 2016, the authorized project alignment consists of a buried seawall/armored levee along most of the study area (approximately 80%) serving as the first line of defense against storm surge flooding and wave forces. The other part of the alignment consists of floodwall and levee. The National Economic Development (NED) Plan as authorized is designed to manage and reduce the risk of storm damage due to waves, erosion, and flooding for coastal storms with a total still water elevation of +15.6 ft. National Geodetic Vertical Datum of 1929 (NGVD29) (the equivalent of +14.5 ft. North American Vertical Datum of 1988 (NAVD88)), which is about 2 feet higher than the peak water levels experienced in the study area during Hurricane Sandy (October 2012). At the time of the Director's Report (2016), this stillwater elevation corresponded to a 0.33% Annual Exceedance Probability (AEP) event under historic sea level change conditions through the end of the economic period of analysis (2025-2075).[9] Figure 1 shows an aerial overview of the study area along with the coastal storm risk management measures to be provided by the NED Plan.

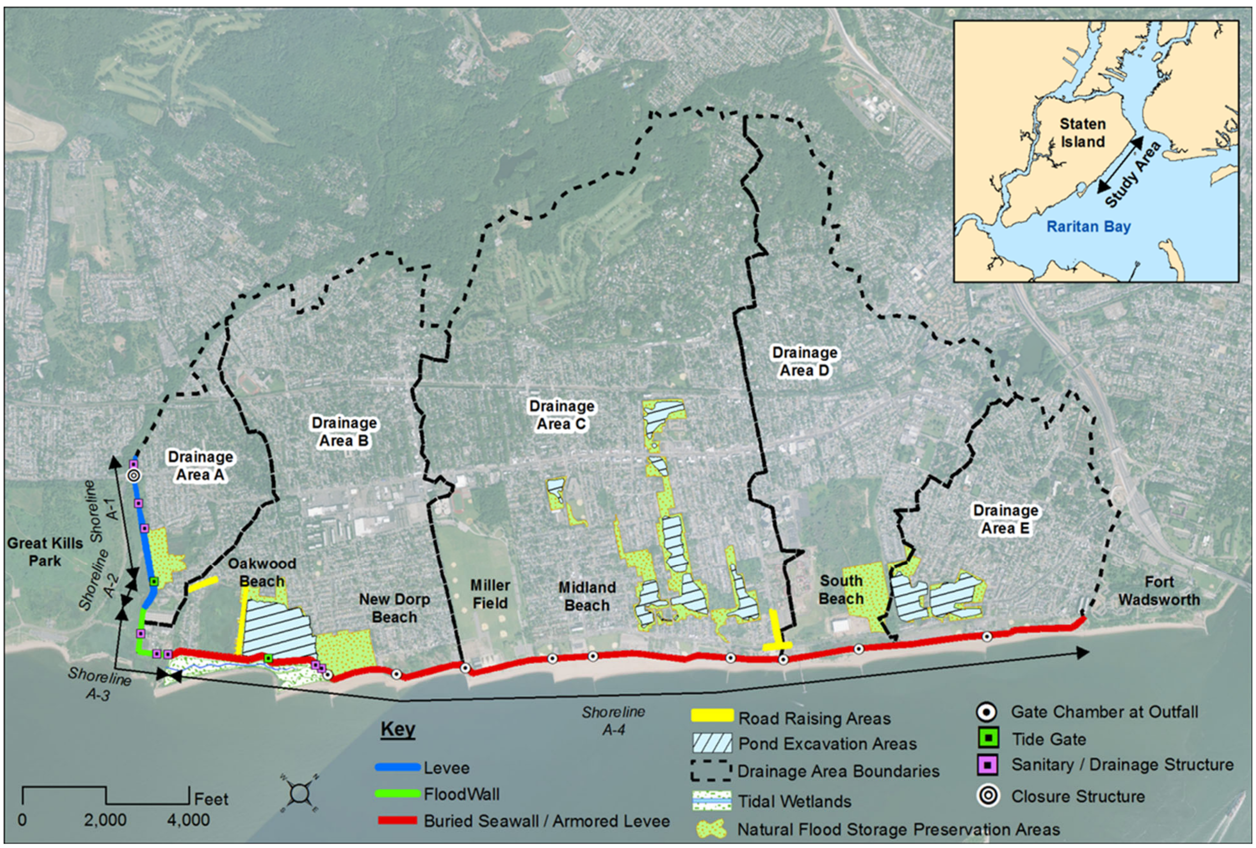

Figure 1 South Shore of Staten Island Project area as presented in the Director's Report (2016).

[9] Based on the updated construction schedule, the current period of analysis is 2032-2082.

The project alignment documented in the Director's Report generally consists of three typical structures, with a total length of 5.3 miles, and a still water design level of +15.6 ft NGVD29 (+14.5ft. NAVD88):

- Shoreline Reaches A-1 and A-2: Earthen Levee (3,400 ft.), with crest elevation of +18 ft NGVD29 (+16.9 ft NAVD88) and crest width that ranges from 10 to 15 ft. The levee terminates into high ground northwest of Hylan Boulevard. A road closure structure along Hylan Boulevard will be deployed only during coastal storm events severe enough to have the potential to flank the levee to manage risk against flooding to the project area,
- Shoreline Reach A-3: Vertical Floodwall (1,800 ft.), consists of H-pile supported T-shaped concrete floodwall with top of wall elevations of +20.5 ft NGVD29 (+19.4 ft NAVD88); a reinforced concrete floodwall is provided where a confined footprint is needed to minimize impacts to the Oakwood Beach wastewater treatment plant (WWTP). A fronting tidal wetland will attenuate the wave forces and preserve the functionality of the tidal creek through a tide gate to the freshwater wetlands that serve as part of the project’s interior drainage,

- Shoreline Reach A-4: Buried Seawall (22,700 ft.), consists of a buried seawall with crest elevations of +20.5 ft NGVD29 (+19.4 ft. NAVD88) with a 10- to 18-foot-wide crest and 1.5:1 side slopes. A 10- to 18-foot-wide scour apron is incorporated into the seaside structure toe. The seaward face and/or the landward and seaward faces of the above-grade portions of the structure are covered with excavated material to support native beach vegetation. The material cover is used to visually integrate the buried seawall with surrounding topography. A functionally equivalent raised promenade atop the buried seawall is provided from Oakwood Beach through Miller Field (approximately 1.75 mile), while an approximately 2.5 mile long, 38-ft wide pile supported functional equivalent boardwalk is provided between Miller Field and Ft. Wadsworth.

The interior drainage plans include the acquisition and preservation of open space, pond excavation, construction of tide gates and gate chambers along the project alignment and other minor interior drainage measures necessary to meet the selected interior drainage plan.

Because high rates of sea level change may affect the performance of the optimized NED Plan, adaptability to rising sea levels is planned. The intent in developing the adaptability measures is to minimize enlarging the structure footprint. Therefore, the project features were developed to support future raising of the structure height within the existing cross-sectional structure footprint where possible. A reinforced concrete parapet wall and base constructed atop the crest of the buried seawall would allow for raising the crest height of the structure by up to 3 feet to manage risk against overtopping and sliding of the parapet wall due to wave-induced horizontal and vertical forces. This validation report does not include the cost of parapet wall to raise the crest by 3 feet. Authorization for this modification would be pursued in a future decision document, to be prepared when trigger conditions for relative sea level change are met, as described in section 9 of this report. These details are presented for informational purposes, and to serve as a basis for future, formal requests to modify the structure.

Real Estate Requirements

The Director's Report presumed that the authorized project would impact 713 parcels, including streets and rights-of-way, including 211 privately-owned and 502 publicly owned (including two federally owned) parcels. The Real Estate plan stated that 42.58 acres in fee; 338 acres for permanent easements; and 48.93 acres for temporary easements were required to support the construction, operation, and maintenance of the Project. As a result of design adjustments, the real estate and associated acreage requirements for this project have changed and the estimated impact has now been reduced to 694 parcels, including streets and rights-of-way. It is determined with the current design that 286 privately-owned and 408 publicly owned (including two federally owned) parcels would be affected by the Project. The increase in private parcels is because properties have been identified where no work is occurring, but would be subject to ponding easements to account for increased flooding. These were not fully captured in the feasibility phase. As the design is further refined, elements may be incorporated to minimize the effect and/or avoid these properties. However, based on the current design they are required. Further explanation of the adjustments affecting the real estate are outlined in section (7).

Local Cooperation

The New York State Department of Environmental Conservation (NYSDEC) is the partner/non-federal sponsor for the project. NYSDEC entered into a Project Partnership Agreement (PPA) for the SSSI Project with the federal government on February 15, 2019. The City of New York City (NYC) also entered into the agreement as a party to the agreement, and as a local sponsor to NYSDEC.

Under the current PPA, the cost of the coastal storm risk management project will be cost-shared 65% by the federal government and 35% by the non-federal sponsor. The non-federal share may be paid through a combination of cash, credits for Lands, Easements, Rights-of-way, and Relocations and in-kind services. Consistent with Section 8402 of WRDA 2022 (described in Section (2) of this report), it is expected that additional costs beyond those contained in the original PPA would be cost-shared as 90% Federal and 10% non-Federal.

(2) Authorization.

The study was authorized by a resolution of the U.S. House of Representatives Committee on Public Works and Transportation and adopted May 13, 1993. The resolution states that:

> *"The Secretary of the Army, acting through the Chief of Engineers, is requested to review the report of the Chief of Engineers, on the Staten Island Coast from Fort Wadsworth to Arthur Kill, New York, published as House Document 181, Eighty-ninth Congress, First Session, and other pertinent reports, to determine whether modifications of the recommendations contained therein are advisable at the present time, in the interest of beach erosion control, storm damage reduction and related purposes on the South Shore of Staten Island, New York, particularly in and adjacent to the communities of New Dorp Beach, Oakwood Beach, and Annadale Beach, New* York"

The feasibility study was completed and approved in 2016 using funds provided through the American Recovery and Reinvestment Act of 2009 and the Disaster Relief Appropriations Act of 2013 (hereinafter, P.L. 113-2). P.L. 113-2 provides the authority for 100% federal funding for the completion of costal storm risk management studies that were underway as of October 29-30, 2012 (Hurricane Sandy) and provides eligibility to initiate project construction. A Director's Report (2016) prepared in compliance with the applicable requirements of P.L. 113-2 demonstrated that the project is economically justified, technically feasible, and environmentally acceptable, and that it incorporates resiliency, sustainability, and consistency with the North Atlantic Coast Comprehensive Study (NACCS).

The authorized project addresses the most critical and vulnerable portion of the authorized study area from Fort Wadsworth to Oakwood Beach. The remainder of the authorized study area from Great Kills to Tottenville was evaluated separately and did not result in a recommendation for construction.

Authorization to construct the project using P.L. 113-2 funds was also provided through the Disaster Relief Appropriations Act of 2013. Chapter 4 of P.L. 113-2 authorizes USACE "For an additional amount for "Construction" for necessary expenses related to the consequences of Hurricane Sandy, $3,461,000,000, to remain available until expended to rehabilitate, repair and construct United States Army Corps of Engineers projects: Provided, That $2,902,000,000 of the funds provided under this heading shall be used to reduce future flood risk in ways that will support the long-term sustainability of the coastal ecosystem and communities and reduce the economic costs and risks associated with large-scale flood and storm events in areas along the Atlantic Coast within the boundaries of the North Atlantic Division of the Corps that were affected by Hurricane Sandy…"

Chapter 4 of P.L. 113-2, also provides "That upon approval of the Committees on Appropriations of the House of Representatives and the Senate these funds may be used to construct any project under study by the Corps for reducing flooding and storm damage risks in areas along the Atlantic Coast within the North Atlantic Division of the Corps that were affected by Hurricane Sandy that the Secretary determines is technically feasible, economically justified, and environmentally acceptable."

The Water Resources Development Act of 2022, WRDA 2022 provided further authorization for the project, as described below.

> Sec 8401. Project Authorizations. Authorizes projects to be carried out substantially in accordance with the plans, and subject to the conditions, described in the respective reports or decision documents designated in this section. This section authorizes the South Shore of Staten Island project for construction, based upon the October 27, 2016 Chiefs (Directors) Report at a total cost of $1,671,000,000, with a Federal Cost of $1,086,000,000 and a Non-Federal cost of: $585,0000,000
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> Sec 8402. Special Rules. (a) SOUTH SHORE OF STATEN ISLAND, NEW YORK.—The Federal share of any portion of the cost to design and construct the project for coastal storm risk management, South Shore of Staten Island, Fort Wadsworth to Oakwood Beach, New York, authorized by this Act, that exceeds the estimated total project cost specified in the project partnership agreement for the project, signed by the Secretary on February 15, 2019, shall be 90 percent.
>
> Sec 8148 Advance Payment in Lieu of Reimbursement for Certain Federal Costs. This Section of WRDA 2022 identified the South Shore of Staten Island as a project where the Federal government is authorized to advance the Federal share of funds required for acquisition of LERRD's and performance of relocations, when these costs are projected to exceed the non-Federal share of the cost of the project.

(3) Funding Since Authorization.

The Director's Report for South Shore of Staten Island was signed on October 27, 2016. The Project Partnership Agreement was executed on February 15, 2019 for $615,231,000. PL 113-2 funding has currently been allocated to pay the Federal share of the design and construction of the current approved estimate of this project (not the increased cost estimate documented in this report). The PL 113-2 funds and non-federal funds distributed to date for the design phase of the South Shore of Staten Island project are presented in Table 2.

Table 2 SSSI Funding Since Authorization

SSSI Appropriations under PL 113-2*		
	Federal	**Non-federal**
Per PPA	**$399,900,000**	**$215,331,000**
PPA total: $615,231,000		
Preconstruction Engineering and Design (PED)		
Received to date	$33,500,000	$15,262,000

*Values have been rounded to the nearest 1000s.

(4) Changes in Scope of Authorized Project.

This Report documents the design changes to the seawall portions of the project from Fort Wadsworth to Oakwood Beach, and the associated changes in the cost. The design changes include an increase in the structure height to maintain project performance, and a change in the cross-section design. These changes are introduced in this section, and further details are provided in the later sections (8) Design Changes, and (10) Cost Changes.

The buried seawall segment of the project runs 5.3 miles along the length of the project area from Fort Wadsworth to Oakwood Beach. Changes were made during the preconstruction design phase (PED). The design team now recommends increasing the height of the project from a crest elevation of +19.4 ft NAVD88 to +21.4 ft NAVD88 based on updated coastal analyses including NACCS modeling (extreme wave and still water level statistics) and physical model modeling results. The increased structure height considers overtopping guidance updated post authorization and the recommended changes follow Engineering and Construction Bulletin (ECB) 2019-8. The recommended height increase considers the risk to life safety and is in accordance with the Tolerable Risk Guidelines (TRGs) outlined in ECB 2019-15.

The team also recommends the use of double sheet pile (DSP) for the seawall rather than buried rock as authorized. Building on knowledge gained during this PED phase with regards to subsurface geotechnical conditions, it was determined that the double sheet pile structure was superior to the buried rock in terms of performance and efficiency. Comparing first construction costs of the buried rock versus double sheet pile, the DSP is the preferred method to provide overall risk management for the area from Fort Wadsworth to Oakwood Beach (see Table 10 in section 10 of this report).

There has been a significant increase in the project first cost, which is documented in this report. The Director's Report identified a project first cost of $571,252,000 in FY 17 price levels. This report identifies an updated project cost of $2,094,202,000 in FY 24 price levels. This cost increase exceeds the funds available within the P.L. 113-2 construction account. Details of these cost changes are described in subsequent sections of this report.

4.1 Confirmation of the *Authorized Project*

Considering the latest design changes and cost increases, the formulation undertaken for the Director's Report has been reviewed to confirm that the recommended plan remains the NED plan, and to document that project reformulation is not required. The alternative analysis conducted in the feasibility study consisted of an initial evaluation of 14 measures, which were screened to 4 alternative plans, and subsequently evaluated to identify the Tentatively Selected Plan. As described below, the feasibility analysis and findings remain valid in identifying the seawall as the recommended project primary feature.

For the Director's Report, an initial array of 14 plans, including the no action plan, were considered against the objectives of managing coastal storm risk, managing residual flood damage from rainfall events, and managing the risks to life and safety within the community. The 14 plans can be generally grouped as nonstructural plans (either floodproofing retrofits or acquisition), structural plans covering a portion of the study area, and structural plans covering the entire length of the study area. All structural plans covering only part of the study area were screened out during the first round because of high residual damages and failure to meet the objective of managing life-safety risk for residents. Nonstructural plans, whether floodproofing/retrofits or acquisition of structures, were screened out for not being cost effective (benefit to cost ratios ranged from 0.1 to 0.5). Additionally, nonstructural solutions do not address the objective of managing risk to life-safety.

The cost increase for the authorized project would not result in the identification of either a partial structural plan or a nonstructural plan as the solution for SSSI for two main reasons: 1) the cost increase to the authorized project would affect the partial structural plans in the same way as the authorized project, which in turn would decrease the BCR further for those plans; 2) building density within the SSSI study area is not conducive to large scale nonstructural treatments, and space to work is limited, which in turn increases the cost of implementing a nonstructural project. As a result, the findings would not change.

The screening of alternatives identified a final array of alternatives including four alternatives along the entire study area, consisting of 1) beach fill, 2) full road raising, 3) partial road raising, and 4) a seawall. These four alternatives were screened against a still water elevation (surge + tide only) of +10.7 ft NAVD88 (ERDC 1998), which corresponded to a 1% annual exceedance probability. The feasibility phase alternative design crest elevations accounted for a wave setup of 2 feet which was added to the 1% AEP storm surge elevations (0.5 to 1.0 feet for levee tie back areas). In the final array screening, the beach fill alternative had a crest elevation of +16 to +17 ft NAVD88, the buried seawall had a crest elevation of +14 ft NAVD88 (with 2 feet of sand cover to elevation +16 ft NAVD88), and the road raising was to elevation +14 NAVD88.

After the seawall was selected from this final array, different crest elevations and storm surge frequencies were assessed for optimization of net benefits using updated H&H from FEMA modeling efforts. Net benefits were optimized at the stillwater elevation (SWE = 14.5 ft NAVD 88) corresponding to the 0.33 % AEP coastal storm event under the low RSLC (0.4% and 0.9% AEP under intermediate and high)) corresponding to a seawall crest elevation of+19.4 ft NAVD88. After performing physical model testing and updating hydraulic loadings (NACCS 2015) during the PED phase, the seawall crest elevation was raised to elevation +21.4 feet NAVD88 to meet the wave overtopping threshold for the design event. To validate this result, the heights of the beach fill and road raising would have to be increased from +16 ft NAVD88 and +14 ft NAVD88 respectively to the equivalent of +21.4 NAVD88 seawall that has been developed through the 10% design phase for valid comparison. Note that this exercise includes planning level assumptions per risk informed planning. A full comparison would require designing these alternative plans to 10% design, which would likely be prohibitively time and resource intensive for potentially reaching the same conclusion stated in the Director's Report.

<u>Evaluation of price-level increases</u>

The first step in determining if the screening of alternatives would hold true is checking to see if price level adjustments would impact the alternatives equally. In order to calculate this, the cost indices of the feature codes listed in EM 1110-2-1304, 30 September 2023 were extracted to see how the increases for specific feature codes might affect the update of costs for alternatives from FY15, when the screening of the final array of alternatives was conducted, to FY24 (date of this Validation Report). Table 3 shows the yearly cost index for the road raisings (08), seawalls (10), and beachfill (17) accounts from Table 2 of EM 1110-2-1304 (30 September 2023 publication).

Table 3 Change in Yearly Cost Indices from FY15 to FY24 for Specific Feature Codes

Feature Code	FY15	FY24*	Adjustment factor
08 – Roads, Railroads, and Bridges	822.62	1172.87	1.43
10 – Breakwater & Seawalls	818.17	1132.54	1.38
17 – Beach Replenishment	852.65	1169.59	1.37

*Data developed based on OMB projections

This price-level check shows that adjusting the preliminary feasibility cost estimates for price level updates only, the seawall alternative and the beachfill alternatives would be similarly affected, with the similar adjustment *factors (1.38 and 1.37) for* the primary feature in each alternative. Road raisings would have a *higher adjustment factor (1.43) and* would therefore be less likely to have higher net benefits, assuming the same level of performance. Table 4 shows the screening table for the four alternatives in the final array (Table 15 of the Director's Report) with price level adjustments from *FY15*, when the comparison of the four alternatives were conducted, to current price levels. This illustrates that based upon price level updates, specific to the feature type, the seawall would remain the primary feature of the recommended plan.

Table 4 Preliminary Comparison Based on Price Level Adjustment from FY15 to FY24

Comparison of Final Array of Alternatives from SSSI Director's Report				
Project Alignment Plan	**Alt #1: Beach Fill**	**Alt# 2: Road Raising (Full)**	**Alt#3: Road Raising (Partial)**	**Alt#4: Buried Seawall/Armored Levee**
Average Annual Benefits (FY15)	*$12,557,000*	*$12,908,000*	*$12,908,000*	*$12,908,000*
Average Annual Benefits (FY24)[1]	**$16,274,000**	**$16,729,000**	**$16,729,000**	**$16,729,000**
Average Annual Costs (FY15)	*$7,148,000*	*$5,946,000*	*$7,132,000*	*$5,460,000*
Average Annual Costs (FY24)[2]	**$9,805,000**[3]	**$8,478,000**[4]	**$10,169,000**[4]	**$7,558,000**[5]
Net NED benefits (FY15)	*$5,409,096*	*$6,962,429*	*$5,776,429*	*$7,448,429*
Net NED benefits (FY24)	**$6,442,000**	**$8,251,000**	**$6,560,000**	**$9,171,000**
BCR (FY15)	*1.8*	*2.2*	*1.8*	*2.4*
BCR (FY24)	**1.7**	**2.0**	**1.6**	**2.2**

[1] Annualized benefits were updated using an adjustment factor of 1.296 from the historical Consumer Price Index, FY15 (237.433) to FY24 (307.671)
[2] Annualized costs were adjusted adjustment factors developed from the yearly cost index for the dominant feature code in each alternative, as described in Table 3.
[3] Adjustment factor of 1.37 from Feature Account 17 – Beachfill
[4] Adjustment factor of 1.43 from Feature Account 08 – Roads, Railroads, Bridges
[5] Adjustment factor of 1.38 from Feature Account 10 – Breakwater and Seawalls

However, a comparison on price level update alone is insufficient, as there is a substantial difference in the sizes of the alternatives being compared, and the size of the plan ultimately recommended. The alternatives for beachfill and road raising were developed to the 1% AEP coastal storm event (based upon 1998 modeling), while the seawall was chosen and then ultimately optimized to the 0.33% AEP coastal storm event in reference to low SLR conditions (based upon updated FEMA modeling) for the final report (crest elevation of +19.4 NAVD88 in the Director's Report recommendation). In the design phase, as discussed elsewhere in this Validation Report, the seawall was modified to +21.4 ft NAVD88 to meet the selected wave overtopping performance requirements for the design water level.

Beachfill

The beachfill plan in the Director's Report was screened at a height of +16 to +17 ft NAVD88, which corresponded to an acceptable level of performance for the 1% AEP coastal storm event (Figure 2). The cross-section included a dune with a 40 ft crest width, and a berm of 75 ft, sloping down 1:15. This section had an overall width that averaged 355 feet from the landward toe of the dune to the constructed shoreline. A plan view of this concept can be seen in Figure 3. This cross-section required placing 3.2 million cubic yards (cy) of sand to provide the design profile needed to manage risk against storm surge. It was noted in the work leading to the Director's Report that this profile could be difficult to maintain and could leave the project area vulnerable to flood damages over the course of the erosion/ renourishment cycle, particularly when exposed to multiple coastal storm events.

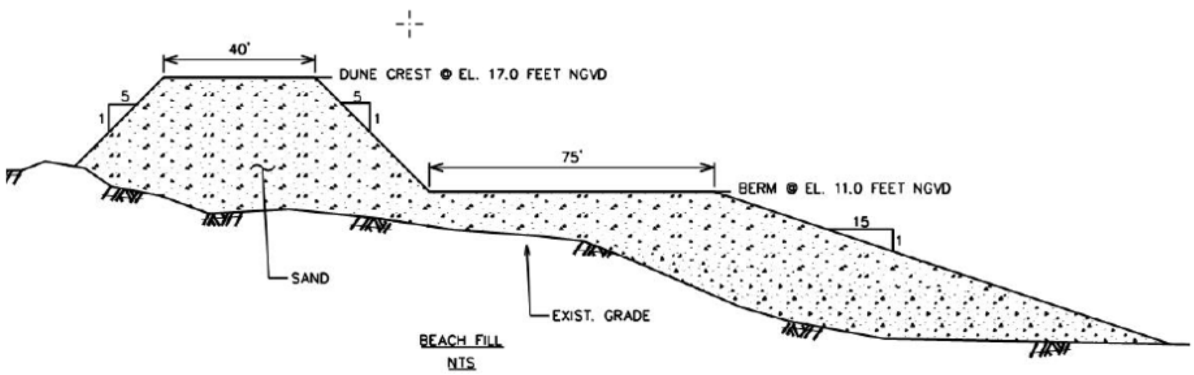


Figure 2 Beachfill profile from SSSI Director's Report

Figure 3 Plan View of beachfill alternative from Director's Report.

To be comparable to the +21.4 ft NAVD88 seawall the size of the beachfill alternative would need to be increased to meet the performance objectives for the design coastal storm event, given the latest wave and water level data (NACCS 2015). The description below draws upon observations of recent projects in the New York District area as a conceptual design for a comparative analysis. Detailed analysis and modeling of beach and dune geometry, grain size, nearshore morphology, longshore currents, and the response to various storms would be required to accurately identify the required beach design template and related increase in initial volume placement.

However, there are existing projects in the vicinity to provide information for a rough order of magnitude estimate. At the screening level of design, a dune two feet higher than the seawall height, with a width of 40 ft was required to provide a comparable level of design. The assumption was made that this would hold true for a larger plan, and that a beachfill could be built to 2 feet higher than +21.4 ft NAVD88, for a crest elevation of +23.4 ft NAVD88, and a crest width of 40 ft (Figure 4). Beachfill design at a higher level of performance also requires a wider berm width, to account for storm induced erosion for the design event. It is assumed that to provide a comparable design, the design berm width would need to be increased to a width of 150 feet. This requirement has been demonstrated on other coastal projects, including Rockaway, Long Beach and Fire Island Inlet to Montauk Point in New York. Applying these design assumptions would increase the width of the cross-section, from an average of 355 feet wide to an average width of 505 feet, when measuring from the landward toe of the dune to the constructed shoreline.

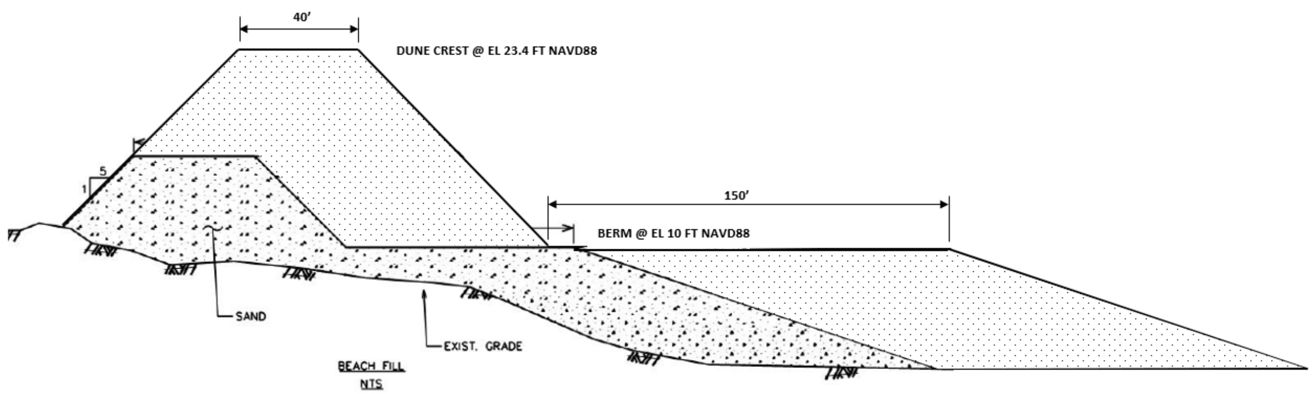


Figure 4 Conceptual Beachfill Design, Comparable to Seawall at +21.4 ft NAVD88. Director's Report template included

A volumetric analysis was done, considering the increased volume of sand required for both the increased dune height, and the increased width of the template over the length of the project. This translates to an additional volume of 3 MCY for the berm and a dune volume increase of 700,000 CY, which, added to the original 3.2 MCY for the beachfill alternative, results in a need for 7 MCY for initial placement.

The original screening of alternatives did not identify a borrow source for construction, and no borrow area identification was conducted as part of the study. In order to estimate construction costs, a review of available borrow areas was undertaken, and a borrow source in the East Bank Shoal was identified that could potentially yield 7 MCY of sand. This is the borrow area identified for the Coney Island Project (Figure 5, labeled as CI). Construction of the beachfill project would require a cutter suction dredge to hydraulically pump sand from the east bank shoal borrow area to Staten Island because of the shallow depth. Given the entrance channel to the NYNJ Harbor, a section of pipe would be routed through a trench dug in the Ambrose Channel to avoid navigation impacts. Sand would be pumped approximately 6.5 miles to the beach, requiring two booster pumps. It is estimated that the construction duration would be about 650 days based on historic production rates for this type of dredging and distances. Accounting for weather, mechanical breakdown and environmental windows work (no dredging between April 01 to June 30, and October 01 to November 30) it would require approximately 5 years to complete with 10 mobilizations (2 mobilizations per year due to environmental windows for dredging). It should also be noted that a full borrow area analysis would be needed to conduct a grain size analysis of the borrow area would need to assess native grain size compatibility and beach suitability. These factors can affect overfill volume requirements, renourishment frequency and regulatory compliance.

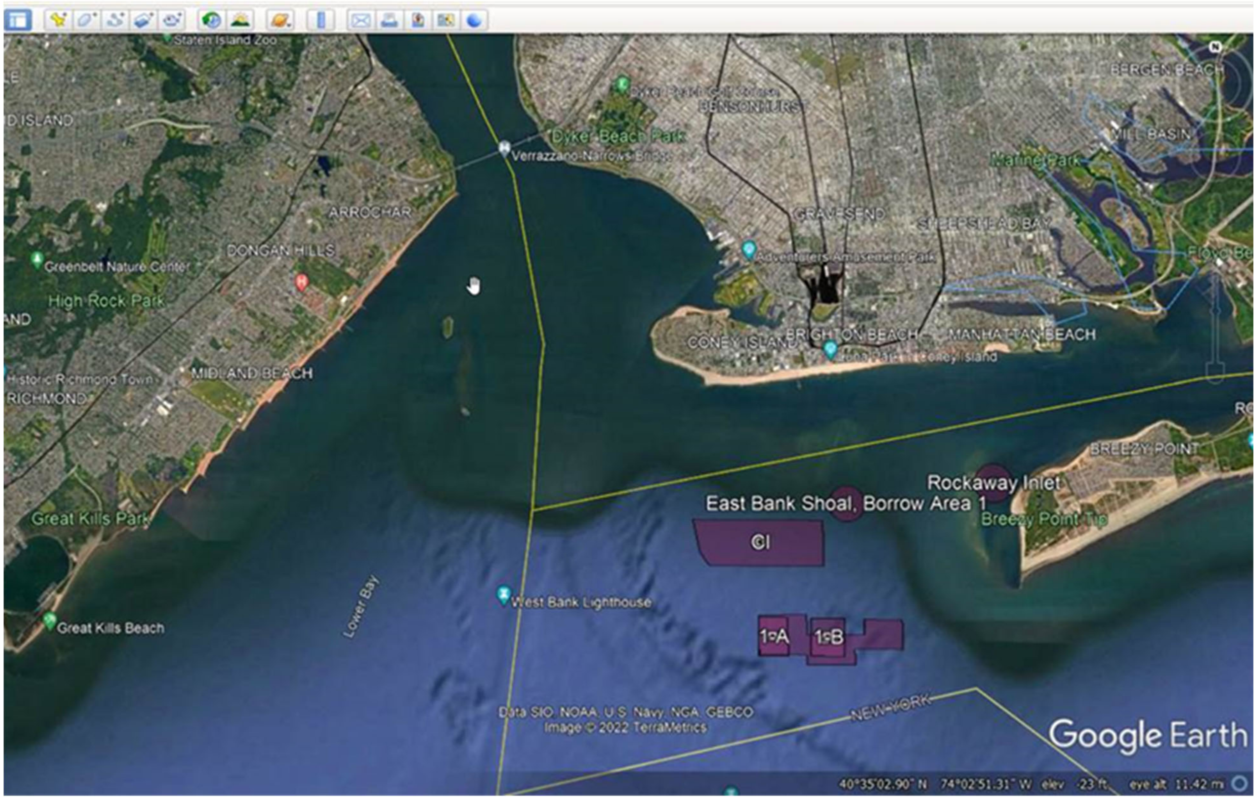


Figure 5 Borrow Area at Coney Island

In addition to the increased volume for initial placement, groins would be needed to help maintain the design template in face of wave activity and sediment transport. The Director's Report included two terminal groins, at 400 ft length. There are also currently 17 existing outfalls that would need to be extended to account for the larger berm width. These 17 outfalls currently act like groins in compartmentalizing the beach and could be reconstructed in a manner so that the outfalls could function like groins in conjunction with the beachfill. It should be noted, however, that the location of these outfalls is determined by their interior drainage functions, and some may not be in optimal locations to function as groins. The two groins from the Director's Report would still be needed at a minimum, and perhaps more groins, likely to a greater length than 400 feet.

After initial construction, it is assumed that nourishment would be on 10-year cycles, as in the screening report and using the Coney Island project as a reference. The Director's Report assumed 650,000 CY every ten years based on the smaller design template. Given that the renourishment of a beachfill plan increases with a departure from the existing shoreline, an assumption was made regarding the increase in renourishment needed. Estimating the nourishment volume would require modeling to arrive at the requisite amount, but an estimate was made by increasing the nourishment volume by 35% to 877,500 CY every 10 years for an initial placement volume of 7 MCY. Another consideration in the design is the beachfill alignment and the current use of the project area. The dune alignment was assumed to be located seaward of the existing boardwalk. The existing boardwalk is currently at a height between +16 ft NAVD88.

The road raising alternatives, whether partial or full, were identified as a cost risk during the feasibility study because of the unknown utility relocations in an urbanized environment. Alternatives 2 and 3 required full and partial road raising as the primary measure to manage coastal storms (Figure 6). Alternative 2 required road raising for the entire length of Father Capodanno Boulevard which runs parallel to the shore for approximately 14,000 ft and 6,800 ft of armored levee from Miller Field to Oakwood Beach. Alternative 3 is a slight variation of Alternative 2 but called for *partial* road raising of Father Capodanno Blvd. and raising of the existing promenade. Road raising (partial and full) has potential to impact the exposed population. With this option, elevating the road a foot or higher above grade will result in overtopping waters to drain onto structures in low lying areas. As experienced during Hurricane Sandy, the bowl-like shape of the area north of Father Capodanno Boulevard created substantial ponding and increased life loss risk.

Figure 6 Plan View of Road Raising Alternatives from the Director's Report

There would be additional challenges in increasing the height of a road raising alternative from an elevation of +14 ft NAVD88 to +21.4 ft NAVD88 (which would be required to provide a comparable level of risk reduction to the recommended plan). Even at an elevation of +14 ft NAVD88, for road elevation, there are numerous properties along the road that would need to be raised, with roads and driveways also adjusted to allow for access. Increasing the road height by 7 ft would likely be impractical. Adjacent buildings would likely need to be acquired, and modifications to roadway intersections would be daunting. The cost of utility relocations could also be prohibitive, as the height requirements for fire hydrants and manholes would be seven feet greater. In addition to relocations being potentially cost prohibitive, this alternative would also be subject to the same, if not greater, increases in building material costs as the seawall alternative.

Conclusion

As outlined above, screening assumptions made during plan formulation are still valid and the seawall remains the best solution to reduce the risk of life-loss while providing the highest net benefits. Accordingly, no reformulation is required. Based upon price-level adjustments of the alternative comparison, the seawall plan remains the preferred plan. A conceptual update of plans at the same scale as the authorized seawall show that a beachfill alternative is plausible; however, it is not more cost effective (at a cost ranging from $2.7 billion to $3.8 billion) than a seawall and would be more vulnerable to breaching during extreme coastal storm events. There are also doubts that the larger footprint would be permitted under New York State law. A beachfill alternative may also have greater vulnerability in between nourishment cycles and is less likely to meet life safety considerations than a seawall. The other primary measure, road raising, is impractical at the same scale as the recommended plan, involves costly utility relocations, in addition to creating a life-safety hazard due to the local topography. The seawall project footprint could be minimized based on construction techniques (i.e., using double sheet pile rather than rock for the seawall). Overall, the seawall alternative is the most effective and cost-efficient method of providing coastal storm risk management to SSSI.

(5) Changes in Project Purpose.

There is no change in project purpose, as coastal storm risk management remains the primary project purpose. The authorized purpose is to implement solutions to problems and opportunities associated with coastal storm damage in the study area.

(6) Changes in Local Cooperation Requirements.

Based upon the language contained in WRDA 2022, there are changes in the local cooperation requirements. Section 8402 of WRDA 2022 has adjusted the cost-sharing requirements for the project, so that costs that are greater than those contained in the 2019 PPA are cost shared at 90% Federal and 10% non-Federal. Section 8148 also identifies this project as one that could be eligible for advance payment of certain Federal costs, in lieu of reimbursements. If this provision is applied, it could further change the requirements of the local sponsor. This report will provide an updated cost estimate and will establish the estimated Federal and non-Federal costs for the project. NYSDEC, the Non-Federal Sponsor, agreed to provide its share of costs in accordance with the terms and conditions of the Project Partnership Agreement executed on 15 February 2019. The Non-Federal Sponsor committed to its share of construction costs including land easements, relocations, and disposals (LERRD) pursuant to applicable law as authorized. The non-federal sponsors agree with recommended solutions that uphold authorized project purpose and performance.

(7) Changes in Real Estate

This section identifies changes to the authorized plan described in the Director's Report. Recommended changes to the project’s Lands, Easements, Rights-of-Way (LER) requirements are based on updated engineering analysis and design data affecting the real estate needed to support construction, operation, and maintenance of this project.

Please note, the project contracts listed within the 2016 Real Estate Plan (REP) have been rearranged and real estate requirements sorted across 7 separate contracts so the information may appear different from the original REP.

Contract #1 which consisted of Interior Area A & B and the LOP beginning at the vicinity of Hyland Blvd and Buffalo Street and ending at the vicinity of New Dorp Lane and Miller Field is now reflected as Contract #2 – Floodwall, Contract #4 – Interior Drainage Area A, Levee, & Hyland Blvd, and Contract #5 – Interior Drainage Area B & Seawall from Oakwood to Miller Field.

Contract #2 which consisted of Interior Drainage Areas C, D, E and the LOP beginning at the vicinity of New Dorp Lane and ending at the vicinity of Ayers Road near Fort Wadsworth is now reflected as Contract #1 – Interior Drainage Area E, Contract #3 – Interior Drainage Area C, Contract #6 – Interior Drainage Area D & Seawall from Midland Beach to Fort Wadsworth, and Contract #7 – Miller Field.

Further review of each individual property has resulted in the refinement of required acreage and the rearranging of specific parcels between the different contracts. Furthermore, a revision has been made to those properties identified as requiring fee interest. There are certain types of improvements which require fee interest per ER 405-1-12, Chapter 12-9. The improvements/uses of the properties listed as fee interest in the real estate plan did not meet the threshold for fee interest and so the appropriate easement interests were applied to those properties rather than fee interest. Each contract is in various stages of completion. As each design moves toward 100%, refinements to those designs may lead to additional real estate adjustments in the future.

The most significant adjustment to real estate has occurred within Interior Drainage Area C. The Non-Federal Sponsor in conjunction with New York City have adjusted the project scope to exclude all properties north of Olympia Ave as NYC will be taking responsibility for this portion of the project as part of their Bluebelt Initiative. This change in scope reduced the number of properties from 378 to 205.

In addition, the original USACE design for Interior Drainage Area C was adjusted to identify additional properties required to support the drainage of the project. These properties will be intended as natural habitat storage preservation areas with the real estate interest being a restrictive easement and are not expected to require any construction. Real estate acquisition is needed to ensure no future construction occurs within those properties to support drainage for the project. At this time, 32 residential properties have been identified as required for Interior Drainage Area C. As the NYC design plans progress, the team will be looking to work with NYC to design around these properties. Until the data properly reflects these properties are not required, they have been included within the RE parcel listing and RE cost estimate total. The resulting impact of this adjustment has increased the number of parcels required for Interior Drainage Area C from 205 to 349 properties. Overall, the total acreage required for Interior Drainage Area C has been reduced from 86.15 acres to 66.58 acres.

Both Interior Drainage Area A and Interior Drainage Area B required additional properties for natural habitat storage preservation resulting in an increase in acreage from 12.14 acres to 23.31 acres for Interior Drainage Area A and an increase in acreage from 33.94 acres to 38.73 acres for Interior Drainage Area B.

Design adjustments between REP and USACE 60% design of Interior Drainage Area E has resulted in an increase of acreage from 41.97 acres to 49.35 acres. The additional acreage is primarily based on the increased size of the ponding area. Additional modifications were requested by NYC and adjustments through 100% design will be completed by NYC in support of their Bluebelt initiative. These additional design adjustments beyond the USACE 60% design will be considered above and beyond the requirements of this project.

The remaining project areas generally fall within the same footprint as identified in the initial feasibility study with some adjustments to acreage based on updated design considerations. Table 5-1 shows the changes in real estate based on the latest design adjustments and refinements between the Director's Report and the most recent design submittals.

Table 5-1 Change in Real Estate based on design adjustments and refinements

Changes to LER Acreage*		
Contract #	**2016 REP**	**Update**
Contract #1 – Interior Drainage Area E	**41.97**	**49.35**
FEE	*9.47*	
Ponding Easement	*21.61*	*38.24*
Restrictive Easement	*10.89*	*11.11*
Contract #2 - Floodwall	**7.83**	**8.60**
Flood Protection Levee Easement	3.47	*3.44*
Road Easement	*.29*	*.02*
Temporary Work Area Easement	*4.07*	*5.14*
Contract #3 – Interior Drainage Area C	**86.15**	**66.58**
FEE	18.97	
Ponding Easement	29.71	*47.00*
Restrictive Area Easement	37.47	*19.58*
Contract #4 – Interior Drainage Area A, Levee, & Hylan Blvd	**19.53**	**38.58**
FEE	4.02	
Flood Protection Levee Easement	4.40	*10.54*
Pipeline Easement		*.05*
Restrictive Area Easement	8.12	*23.31*
Temporary Work Area Easement	2.99	*4.68*
Contract #5 – Interior Drainage Area B & Seawall (Oakwood to Miller Field)	**151.06**	**177.13**
FEE	9.57	
Drainage Ditch Easement		*.94*
Flood Protection Levee Easement	24.28	*46.47*
Pipeline Easement	.04	*.14*
Ponding Easement	39.78	*54.52*
Restrictive Area Easement	*33.94*	*38.73*
Road Easement	*1.49*	*3.10*
Temporary Area Easement	*9.63*	*13.38*
Wetland Easement	*32.33*	*19.85*
Contract #6 – Interior Drainage Area D & Seawall (Midland Beach to Fort Wadsworth)	**95.24**	***94.00***
Flood Protection Levee Easement	*32.63*	*56.67*
Restrictive Area Easement	*30.74*	*13.70*
Road Easement		*.18*

Changes to LER Acreage*		
Contract #	**2016 REP**	**Update**
Temporary Easement	31.87	*23.45*
Contract #7 – Miller Field Offset	**15.41**	**15.41**
Wetland Easement	15.41	*15.41*
*Please note, the 2016 REP LER acreages were broken out by Sections whereas updated LER acreages are broken out by contract; the above acreages take into account the location of parcels more befitting to their project location		

Due to the nature of this type of project, several design changes within the LOP have been recommended for the levee, seawall, and floodwall portions of this project. Additional design considerations have also resulted in the expanding of ponding areas primarily within parcels previously identified.

Since feasibility, design adjustments to the levee recommend an increase of levee crest elevation from +16.9 ft to 17.7 ft NAVD88 to allow for long term settlement and maintain a crest height of +16.9 ft over the life of the project. The impact of the height increase is expected to result in a base width growth of between 6-20 ft depending on the location and ground elevation. As a result, the adjusted real estate footprint of the levee is expected to increase in acreage from 4.4 acres to 10.54 acres.

Additionally, a change has been recommended for the buried rock seawall crest elevation from +19.4 ft to +21.4 ft NAVD88 for both the boardwalk & promenade sections of the alignment which is expected to increase the required real estate acreage needed to maintain the proper slope and support a larger footprint for the toe of the seawall. A recommended change to replace the buried rock seawall with double sheet pile construction is expected to limit the increase in footprint. The adjusted footprint to include sand cover required to support a +21.4 ft double sheet pile LOP from Oakwood Beach to Fort Wadsworth is expected to result in an increase of acreage from 61.09 acres to 103.14 acres. The cross section base width to support this configuration is expected to increase by approximately 20-40 ft; however, this design is only based on current known site conditions and is only at the 10% design level. For additional details, see Appendix B of the Environmental MFR.

An additional change was requested to adjust the length of the Floodwall from 1800 LF to 2100 LF to accommodate future construction of an NYCDEP effluent pump station around the Wastewater Treatment Plant (WWTP). This adjustment extends the original Floodwall construction away from the WWTP in the southwest portion of the complex resulting in a minimal change of real estate acreage from 7.83 acres to 8.6 acres.

Further design adjustments, as reflected in Section (8), to Interior Drainage Area B and the Tidal Wetlands have resulted in real estate changes for Contract #5 as reflected in the Table 5. Also, the relocation of Interior Drainage Area D based on modeling data has resulted in a decrease in acreage from 30.74 acres to 13.7 acres.

The modified Project will now impact approximately 694 parcels, including streets and rights-of-way. There are 286 privately-owned and 408 publicly owned (including two federally owned) parcels affected by the Project. The approximate acreage required to support the construction, operation, and maintenance of the project include 403 acres for permanent easements and 46.65 acres for temporary easements. No parcels will be acquired in fee with the new project design change.

Associated Land, Easement, Rights of Way, Relocations, and Disposal Area (LERRD) costs have been adjusted to include increases associated within updated property values, updated incidental costs, follow on costs for RE crediting actions, and increased relocation costs since the 2016 REP. Refinements to design plans and an increase in real estate footprint has resulted in additional relocation costs for utilities and facilities. Certain relocations were not previously known and/or addressed within the 2016 REP. The identification of additional relocation actions not previously addressed have resulted in a cost increase as designs for each contract progress and more research and testing is completed. Table 5-2 shows the changes in cost between the 2016 REP and updated LERRD costs as they exist in their most recent design phase.

Table 5-2 Change in Real Estate Costs

Changes to LERRD Costs		
Cost Account	**2016 REP**	**Update**
01-Lands & Damages	**$42,616,428**	**$93,522,000**
- *Incidental*	*$6,112,124*	*$30,498,000*
- *Acquisition*	*$36,504,304*	*$63,024,000*
02-Relocations	**$42,299,000**	**$74,270,000**
Total Project RE Costs	**$84,915,428**	**$170,400,000**

Please note, as the design for Interior Drainage Area C progresses, there is an opportunity to possibly avoid 32 residential properties currently required under the 30% USACE design. Assuming all properties can be avoided, a total savings of approx. $14.7M can be expected from the 01-Lands & Damages cost account. As mentioned previously, at this time the design plans require these properties and therefore these properties and the associated value of these properties are included within this Validation Report. The expectation moving forward will be to avoid as many of these properties as possible as NYC progresses with their design of Interior Drainage Area C.

(8) Design Changes.

The authorized plan described in the Director's Report spans a total length of approximately 5.3 miles consisting of 22,700 ft of buried seawall with crest elevation of +19.4 ft NAVD88, 1800 ft of vertical floodwall with top elevation of +19.4 ft NAVD88, and 3400 ft of earthen levee with crest elevation of +16.9 ft NAVD88, and interior drainage features which include the acquisition and preservation of open space, various pond excavations, construction of tide gates and several gate chambers along the project alignment, and other interior drainage measures as outlined in the Director's Report.

This section itemizes changes to the authorized plan described in the Director's Report based on engineering analysis done to date. Recommended changes to the authorized plan are based upon updated geotechnical information, updated water level, wave data, and latest coastal engineering analyses, including physical modeling and probabilistic overtopping analysis per updated design guidance (ECB-2019-8 and -11). Further details on the design changes are found in the reference materials cited in this report. During design, each of these features will be reviewed using a VE-like process to ensure they do not exceed the minimum USACE requirements. The following changes were made to the authorized plan:

Seawall (Oakwood to Miller and Midland to Fort Wadsworth)

- Change in seawall section from buried rock armored levee with 1.5:1 side slope and a single vertical steel sheet pile wall to a double row of sheet pile (DSP) with fill in between and rock protection
    - Why? Larger wave conditions and physical model tests resulted in changes to the BRS section and a significant cost increase. An alternative DSP section was developed and shown to be the least cost option. The DSP relies less on large size armor stone and

steel strength and more on the mass of fill contained between two rows of sheet pile connected with concrete beams working as a gravity structure to resist the design surge and wave loads.

- Slight realignment of seawall from Director's Report
  - Why? Due to improved survey information on the sewer interceptor and outfall locations and to maintain beach width.
- Rock Crest elevation from +19.4 to +21.4 feet NAVD88
  - Why? To maintain overtopping performance per updated wave inputs and physical model results. Overall height of project is unchanged at +21.4 ft NAVD88. During feasibility, the +19.4 ft NAVD88 rock crest elevation was topped by the timber boardwalk or concrete promenade for an overall height of +21.4 NAVD88. The now recommended DSP section has a concrete cap crest elevation of +21.4 ft NAVD88, which has an auxiliary function as a boardwalk/promenade. Because the cap is integral to the function of the wall, it is not considered a betterment over the timber boardwalk and concrete promenade from feasibility phase
- Waterside slope armor stone size increase from 3 ton to 5 ton based on updated waves and physical model results.
- Removed 3-ton rock slope on back side which is essentially replaced by the landside row of sheetpile in the DSP section.
- Added a landside splash apron with 600lb rock to control overtopping induced scour.
- Total rock weight in Director's Report was 860K ton, in PED total rock weight for the buried rock seawall was 1,300K ton. This has decreased for the double sheet pile to 790K ton.
- Surcharge program, wick drains, and strip drains to offset long term settlement due to soft soil layers (identified in 2019/20, post-Director's Report)

Floodwall at WWTP:

- Increase length from 1,800 to 2,100 linear feet to accommodate future NYC DEP effluent pump station
- Changed 543 feet of T-Wall to concrete capped I-Wall
- I-Wall section crest elevation lowered from +19.4 to +17.4 NAVD88
- Updated guidance requires consideration of an "Extreme" load combination (an event expected to have an AEP of 0.133% or less) and Barge Impact loads
- ~55% more armor stone along west side of OBWWTP
- Approximately 2.5x weight of steel for pile foundations to accommodate higher loads, weaker soils, and 100 YR service life
- Relocated sludge force main to provide room for floodwall
- Additional drainage and utility crossings required special monoliths

Levee, Tide Gate, and Interior Drainage A:

- Crest elevation raised from +16.9 to +17.7 feet NAVD88 to offset long term settlement due to clay layers
- Crest width changed from 10-15 feet in Director's Report to 10 feet along the entire length of the levee.
- Flattened side slopes from 2.5H:1V to 3H:1V to facilitate maintenance and to meet USACE guidance
- Addition of Deep Mixing Method (DMM) foundation support for ~700 feet of levee due to deep clay layers and to provide stable construction access for tide gate
- Staged construction to allow for short term settlement of clay layers
- Added rip rap toe scour protection on the bayside below el. +3.5 NAVD88
- Deep stripping 1.5 to 3 feet deep to remove Phragmites root mat
- Added knee wall south of tide gate to avoid loading on utility pipes

- Turf Reinforced Mat slope stability moved from bayside to landside of levee.
- Added paved access road and turn arounds/maintenance access at tide gate
- Relocated sludge force main to avoid two crossings under project alignment
- Relocated drainage line to avoid crossing under levee and allow to drain into Pond area A
- Replaced existing 30" sludge force main crossing under levee due to its age and unknown condition
- *Tide Gate:*
    - Crest el. Increased from +16.9 to +19.9 feet NAVD88 for future SLC
    - Additional foundation piles due to soils
    - Added sheet pile cutoff
    - Added landside emergency gates
    - Bayside gate changed from slide gate to combination slide-flap gate

Area C Ponds:

- PED decision for USACE to construct only ponds 1-3; Non-Fed sponsor is constructing upper ponds between Director's Report and now to support the project.
- Eliminated need to raise portion of Seaview Ave.

Area E Pond:

- Changed from two ponds (34 acres) to 3 ponds (38.6 acres)[10]
- Pond bottom lowered to -2 feet NAVD88
- 580-foot-long channel added between ponds
- Additional junction chambers, weir chambers, inlets added to align with DEP drainage plans.

Area B Pond:

- Acreage changed from 46 to 48 acres
- Eliminated need to raise mill street between Pond A & B and Kissam Ave. between Area B1 and B2
- Added Relief Diversion Structure on Tysens Lane Outfall to allow water to Divert into Pond Area B2
- Added second tide gate to allow Pond Area B1 to drain out directly to creek

Tidal Wetland/Mosaic of Habitats:

- Overall acreage decreased from 46 acres to 21.7. For more information, please see Table 2 in Appendix B which shows the impacts to wetlands in feasibility and validation
    - Removal of 17 acres of dune grass plantings due to decision to leave existing trap bags and rock in place and not to cover the trap bags in sand.
    - The remaining 29 acres in Director's Report decreased to 21.7 acres due to: location of Oakwood Beach sewer interceptor; Construction of access road; realignment of the project; and decision NOT to remove Cedar Grove Ave.

[10] The Validation Report Total Project Cost Summary is based on the 60% USACE design. The City of New York is paying for additional work in Area E, which is described in this section for consistency with analysis of potential environmental effects. The USACE cost estimate and Real Estate requirements, discussed in Section 7 of this Validation Report, includes only the elements in Area E that would be cost-shared, consistent with USACE policy.

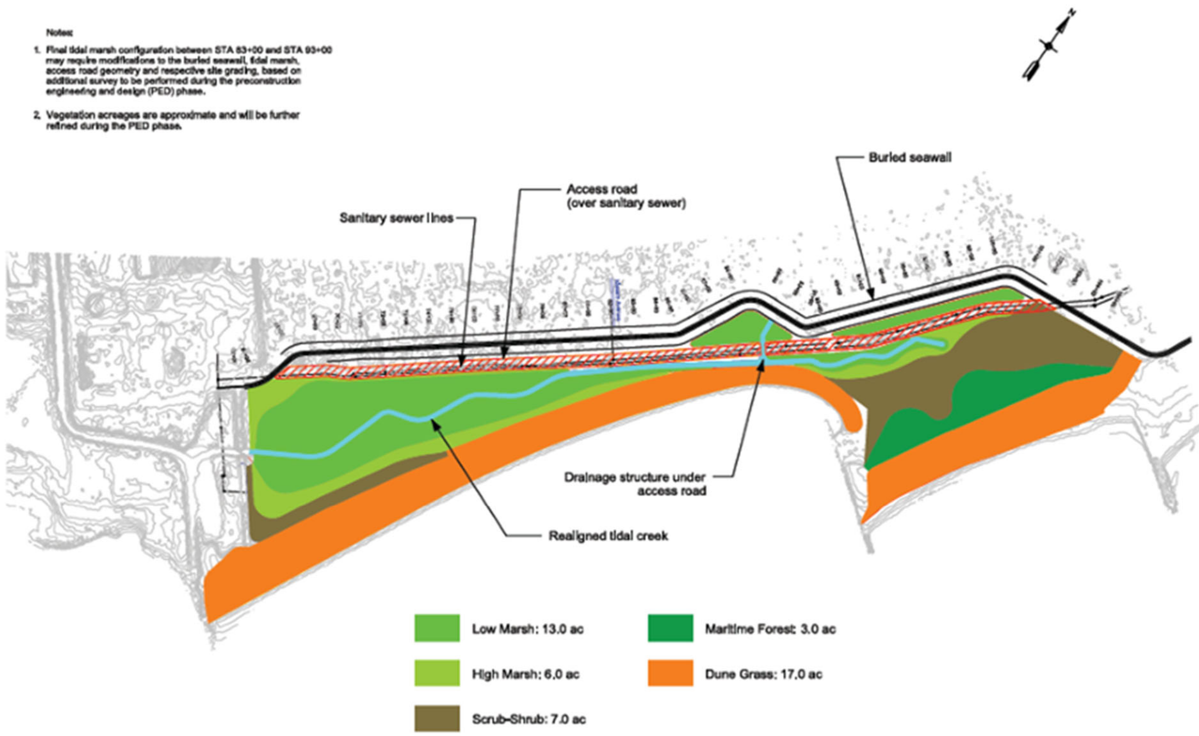


Figure 7 Preliminary tidal wetlands/mosaic of habitats design as presented in the Director's Report

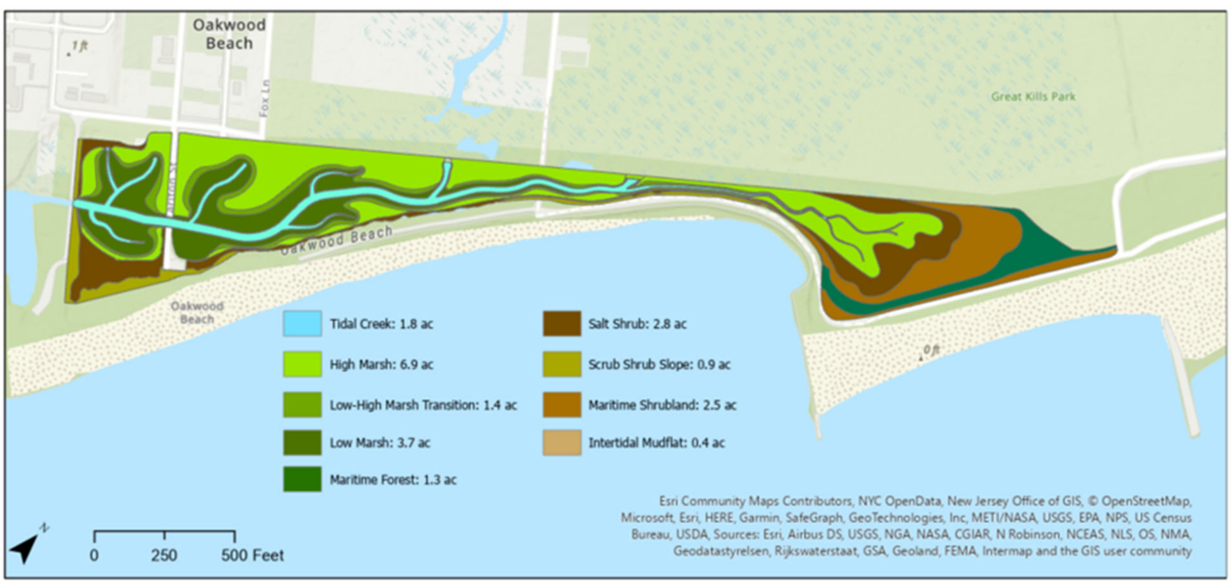


Figure 8 Tidal wetland/mosaic of habitats feature under current designs

The following paragraphs focus on the updates to the coastal design conditions and the changes to the buried seawall section from Fort Wadsworth to Oakwood Beach, as they have the largest effect on the cost updates. Additional details of the design analysis to support these changes are contained in *Reference Material (3): Buried Rock Seawall/Double Sheet pile Wall Promenade and Boardwalk Reaches Alternatives Analysis – Final Memorandum (USACE 2023).*

Waves

The design for the plan recommended in 2016 Director's Report relied on a wave hindcast and wave transformation study performed by the Coastal Engineering Research Center (CERC) in support of the Dredged Material Management Plan for New York Harbor (CERC, 2001). The storm wave results were based on offshore wave hindcast data transformed to the bay using the STWAVE numerical wave model. Representative wave characteristics for the study area were defined based on wave study results at a point in Raritan Bay approximately 3 miles offshore Great Kills at depth of approximately 17 ft MSL. Specifically, the 0.33% AEP significant wave heigh at this location was 9.3 ft.

As part of PED, the more recent and detailed NACCS wave database is being used instead and data at approximately the same location as the one used in the 2016 Director's Report (NACCS, save Point #3528) shows a 0.33% AEP significant wave height approximately 13.5 ft (i.e., 45% larger than in the CERC study used for the 2016 Director's Report). However, these differences offshore are reduced as the waves continue to propagate toward the shoreline over shallow water and are limited by available water depth. Specifically, at NACCS Save Point #11732 which located approximately 0.2 miles offshore Midland Beach the 0.33% AEP significant wave height is reduced to approximately 11 ft or 18% larger than the representative waves used in the Director's Report study.

Overall, this increase wave height from Feasibility to PED, combined with the results of the physical model study (see more details on that in the following paragraphs), resulted in an increase in armor stone size and required crest elevation to maintain damage and overtopping discharge below critical thresholds under the 0.33% AEP event.

Still Water Levels

The 2016 Director's Report recommended a plan that reduces the risk of storm damage with a still water elevation (tide plus storm surge) of +14.5 ft NAVD88. This water level is about 2 feet higher than the peak water levels during Hurricane Sandy and corresponds to a coastal flood event with an Annual Exceedance Probability (AEP) of 0.33% based stage-frequency curves in FEMA's 2013 Preliminary Flood Insurance Study for the City of New York and including 0.7 ft allowance for sea level change (low rate over 50-year economic period of analysis).

As part of the Preconstruction Engineering and Design (PED) phase, NACCS stage-frequency curves have been adopted for the updated designs instead of the FEMA data. However, differences between FEMA and NACCS are relatively small within the SSSI project area and were not a significant factor in the proposed design changes. Specifically, NACCS 0.33% AEP water levels range from +14.4 ft NAVD88 at the east end of the project near Fort Wadsworth to +15.1 ft NAVD88 at the west end near Great Kills (both numbers including 50 years of low sea level change).

2016 Director's Report Buried Seawall Design

The typical buried seawall design developed as part of the 2016 Director's Report consisted of a trapezoidal shaped rock structure with a 10-ft wide crest at an elevation of +19.4 ft NAVD88 and 1.5:1 (horizontal: vertical) side slopes. The structure was designed with two-stone thickness 3-ton armor stone and bedding stone layers placed over existing soils after excavation. In addition, a 10-feet wide scour apron was incorporated into the seaside structure toe. Geotextile fabric was included underneath the bedding layer to minimize loss of sand through the voids. A vertical steel sheet pile wall was included in the interior of the structure to prevent seepage.

A functionally equivalent 38-ft wide pile supported boardwalk with a deck elevation of +21.4 NAVD88 was provided between Miller Field and Fort Wadsworth (2.75 miles), while a functional equivalent raised concrete promenade atop the buried seawall (also at +21.4 ft NAVD88) was provided from Oakwood Beach through Miller Field (approximately 1.75 miles). Both sections are presented below in Figure 9 and Figure 10.

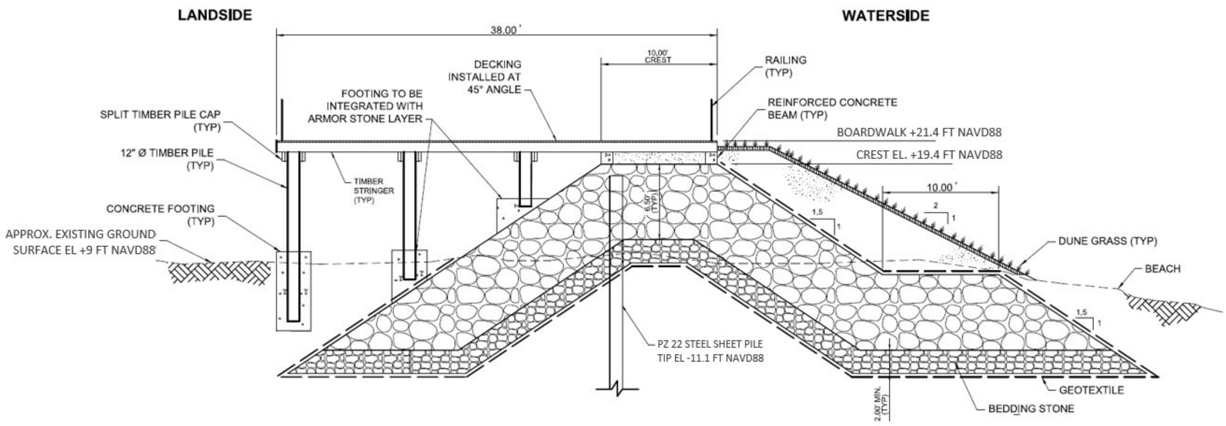


Figure 9 Typical Buried Seawall Section in Boardwalk Reach from Miller Field to Fort Wadsworth in the Director's Report (2016)

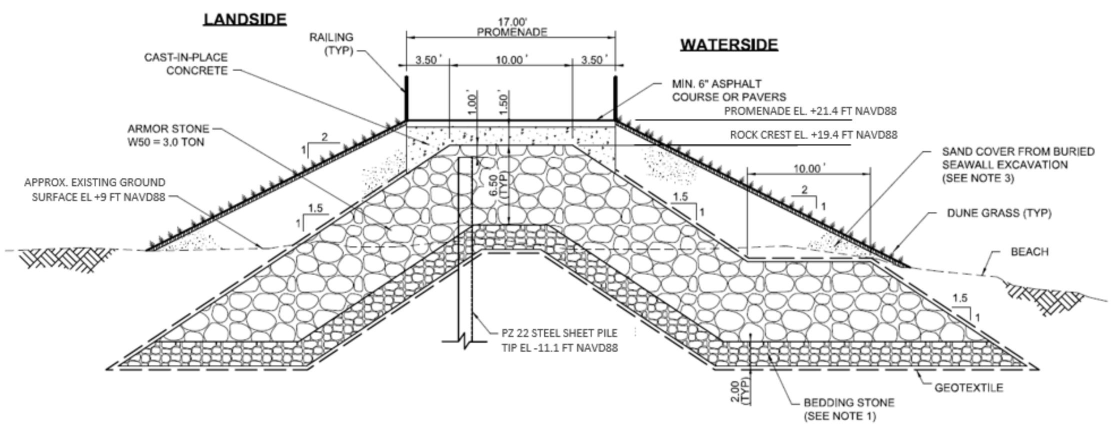


Figure 10 *Typical Buried Seawall Section in Promenade Reach from Oakwood Beach to Miller Field in the Director's Report (2016)*

The rock seawall crest elevation (+19.4 ft NAVD88) was determined based on a maximum allowable wave overtopping rate of 50 liters/m/sec for a still water level (SWL) of +14.5 ft NAVD88 (approximately a 0.33% AEP under low sea level rise). Note that designs, costs, and benefits for four different still water design levels were initially developed and compared as part of an economic optimization process to identify the NED) Plan. The still water design levels were +12.2, +13.2, +14.5, and +15.5 feet NAVD88. Ultimately the +14.5 ft NAVD88 still water design provided the highest net NED benefits and highest BCR of the four still water design levels and was selected as the NED Plan.

Rock seawall crest elevations required to maintain the mean overtopping rate below the critical threshold were established based on the methodology recommended in the EurOtop manual (Pullen et. al. 2007). It is important to note that this methodology and formulations are empirically based and that overtopping (like waves) is a highly complex and random phenomenon which is very sensitive to structure geometry, structure permeability, beach profile, and site-specific wave conditions. For that reason, EurOtop manual recommends the use of deterministic formulas including one standard deviation from the mean to account for the scatter in the empirical data. Finally, armor stone sizes were determined based on armor stone stability methodologies developed by Van der Meer and Hudson as recommended in USACE's Coastal Engineering Manual (CEM).

Change in Rock Crest Elevation

During the initial stages of the PED phase of the project, a detailed physical model study was conducted to verify and optimize as needed the buried rock seawall design recommended in the Director's Report. Specifically, the model study was used to investigate and confirm that:

- overtopping flow rates are acceptable during design conditions,
- all parts of the proposed structures remain stable during design conditions,
- the degree of damage or re-shaping sustained during design conditions is acceptable, and
- scour at the seaward toe is acceptable

The initial series of test in the physical model showed that the 2016 Director's Report buried seawall concept with a +19.4ft NAVD88 rock crest elevation results in an overtopping rate for the design event that exceeds maximum allowable overtopping for beach widths less than 250 ft (MHW to structure toe), which is the existing condition for more than 50% of the existing beach and potentially more than 75% in the future under the high sea level change scenario. More importantly, the minimum/controlling beach width is expected to be less than 250 ft for all design sub-reaches except Cedar Grove Beach.

Both physical model results and additional overtopping calculations using the most recent version of the EurOtop II Manual (Van der Meer, 2018) and calibrated to physical model data show that an initial crest elevation of +21.4ft NAVD88 (i.e., 2ft higher than recommended in the feasibility study) will limit overtopping to less than the design threshold over the economic period of analysis under Low Sea Level Change scenario. In addition, raising the effective crest elevation by 3ft in the future with a parapet wall extension, an adaptive measure recommended in the feasibility study, will maintain overtopping below this threshold for at least 50 years under the High Sea Level Change Scenario or 100 years under the Intermediate SLC scenario. Typical sections for the updated buried rock seawall structure are shown below in Figure 11 and Figure 12.

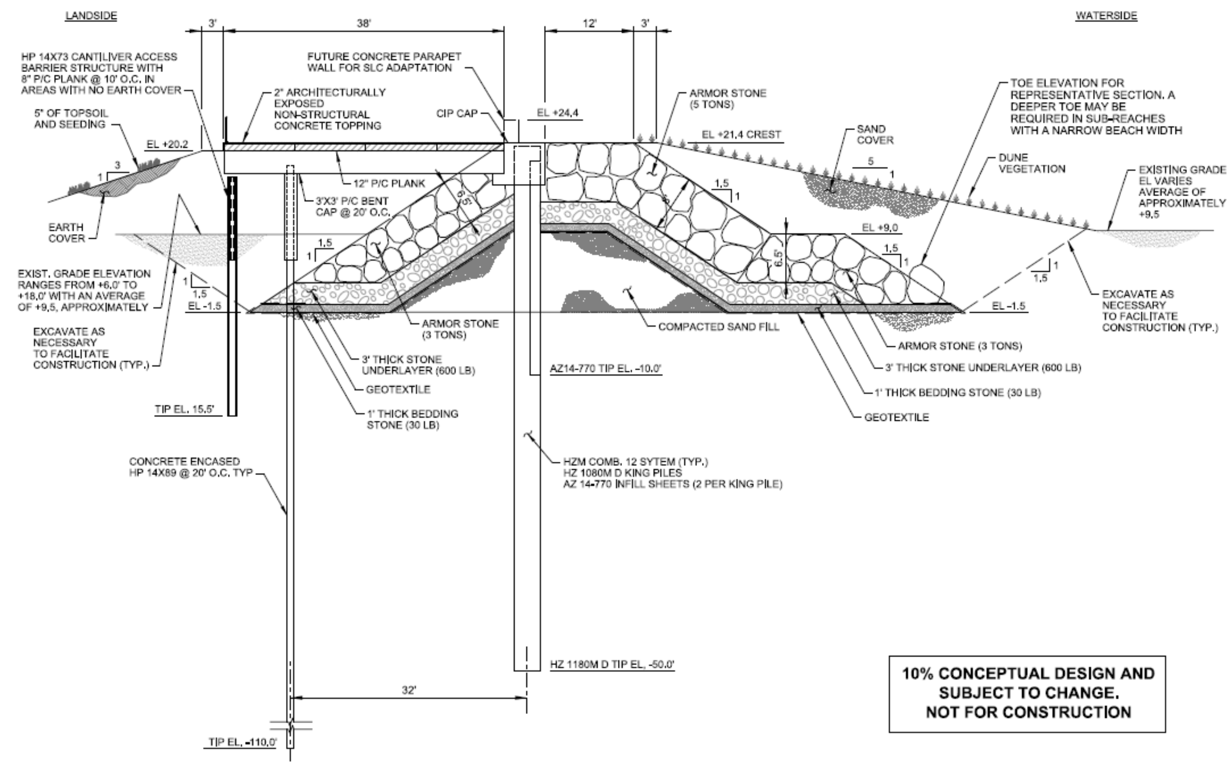


Figure 11 Updated PED (2021) Buried Rock Seawall Section in Boardwalk Reach from Miller Field to Fort Wadsworth

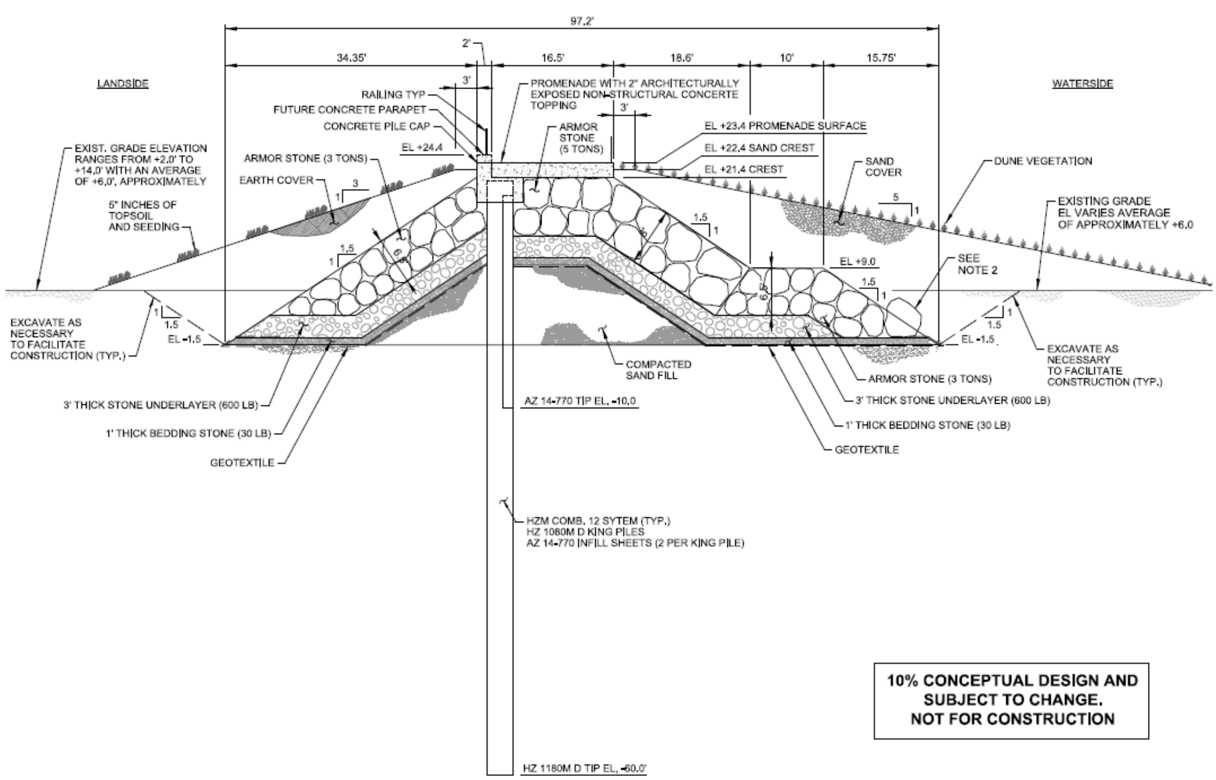


Figure 12 Updated PED (2021) Buried Rock Seawall Section in Promenade Reach from Oakwood Beach to Miller Field

Change in Armor Stone Size

Armor stone damage levels measured in the physical model showed that the typical stone size selected in the feasibility study (3-ton) was adequate for the range of existing beach widths initially tested. However, the tests also showed that a 3-ton armor layer would potentially suffer excessive damage under future eroded beach conditions. Given that replacing / upsizing the armor stone in the future in response to sea level rise and erosion is not a practical alternative, the current recommendation is to increase the size of the armor stone from 3 to 5-ton, which was shown to perform well in the physical model under narrow/eroded profile conditions in combination with the High SLC scenario. These changes are reflected in the updated BRS sections shown above.

Overall, changes in the rock crest elevation and rock size lead to the quantity of stone required for construction of the buried rock seawall increasing from 860,000 tons to 1,300,000 tons, approximately a 51% increase. In addition, unit cost has increased from approximately $135/ton to $239/ton, a 77% increase. The total increase in the cost of rock for the updated buried seawall design is approximately $190M or 157% of the original cost of the rock (without contingency).

Changes in Sea Level Change (SLC) Adaptability Features

The seawall section recommended for initial construction in the feasibility study included consideration of future sea level change over the 50-year economic period of analysis based on historic (low) rates. In addition, the feasibility study generally considered the ability of the proposed structures to adapt to higher rates of sea level change by raising their crest height. Specifically, a reinforced concrete parapet wall and base constructed atop the crest of the buried seawall that would raise the crest height of the structure by up to 3 feet was recommended. It was assumed that a concrete base integrated with the armor layer of the buried seawall could be designed to prevent overtopping and sliding of the parapet wall due to wave-induced horizontal and vertical forces.

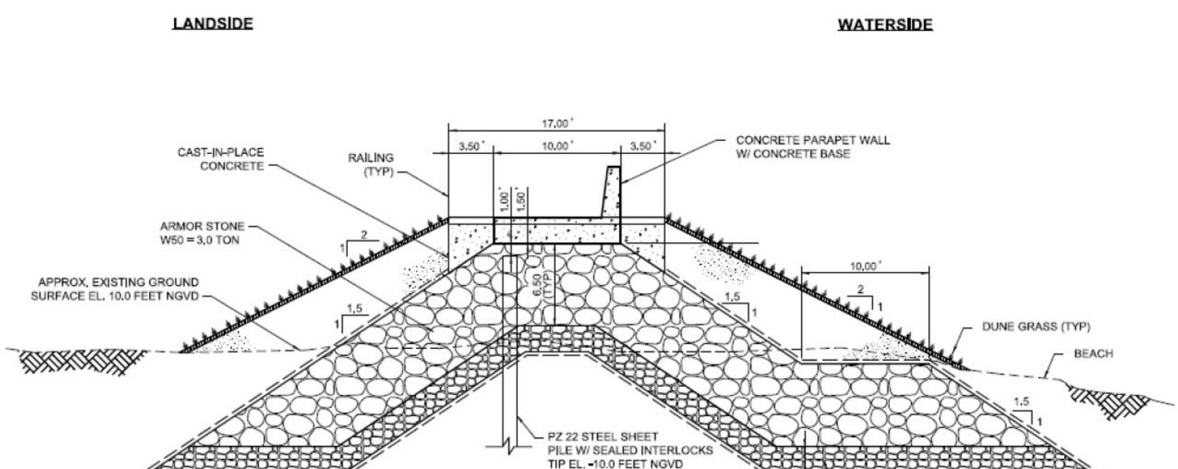
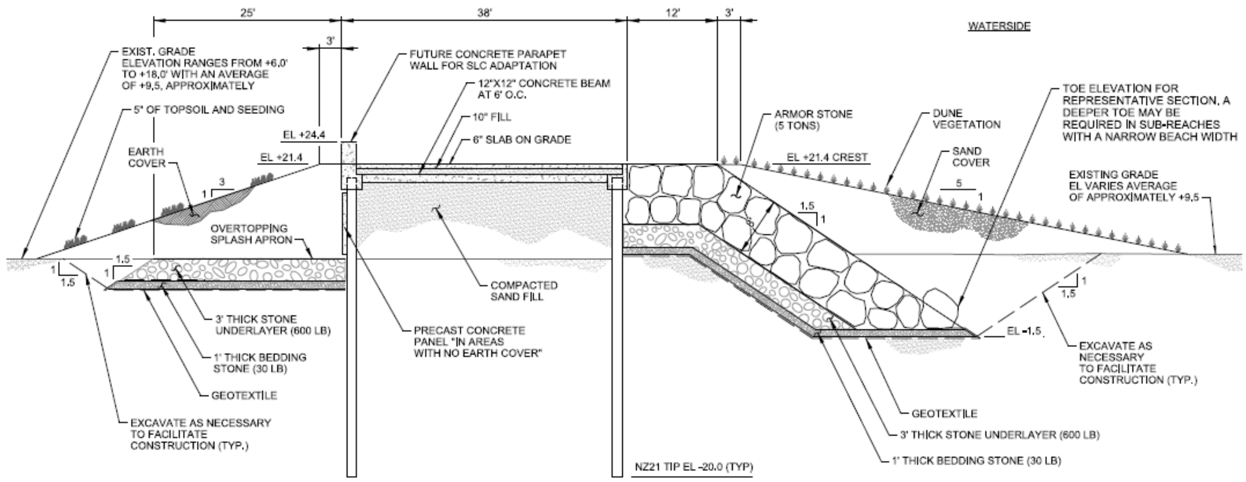


Figure 13 Concrete Parapet Wall atop Buried Seawall (Director's Report, 2016)

However, pressure measurements collected as part of the physical model study show that wave generated forces on the concrete base and parapet wall and the upper portions of the seepage wall will be extreme. Moreover, these forces are roughly tripled between existing water levels and initial wall height vs future water levels under the High SLC scenario and 3ft wall height extension. The scale of these loads requires a deep foundation for the parapet wall and a more robust seepage wall construction. Therefore, an alternative section was developed during PED assuming that the parapet wall would be built as an extension of the "seepage" wall which itself was changed from a relatively light PZ22 steel sheet pile with a -11.1 ft NAVD88 tip elevation to heavier a deeper king pile wall structure consisting of HZM 1180 D King Piles with a tip elevation as deep as -60 ft NAVD and two intermediate AZ 14-770 sheets with a tip elevation at -10 ft NAVD. These changes resulted in a 7-fold increase in the quantity of steel required and together with steel unit costs increases of approximately 50% an overall cost increase of $225 million, from $22 to $247 million, approximately, including the cost of a new concrete cap at the top of the steel wall.

Change from Buried Rock Seawall to Double Sheet Pile Structure

As summarized above, changes in rock crest elevation and rock size lead to an increase in the amount rock required for the seawall, which, combined with a significant increase in unit costs in recent years, results in roughly a $190M increase in the Director's Report costs. This increase, combined with the extremely large breaking wave loads documented in the physical model and associated $225M increase in the costs of the steel seepage wall (i.e., $415M overall), led to the decision to revisit the cross-section design for the buried seawall. Specifically, to consider a double sheet pile wall system that would rely less on large size armor stone and steel strength and more on the mass of fill contained between two rows of sheet pile connected with concrete beams working as a gravity structure to resist the design surge and wave loads. This alternative has the added benefit of directly providing a surface for the boardwalk/promenade without the need for construction of a separate structure on top of or adjacent to the seawall. A rock slope is still required in front of the double sheet pile wall to reduce wave loads and overtopping. Finally, an overtopping splash apron is proposed to dissipate overtopping discharge during extreme events. Typical sections for the proposed double row of sheet pile (DSP) buried seawall structure are presented below. Note that the 3ft high concrete parapet wall shown on these sections is not required during initial construction but could be added in the future to adapt to higher rates of sea level change. More importantly, although the 2016 Director's Report included a rock seawall built to elevation +19.4 NAVD88, the total height of the structure, with the addition of the timber boardwalk or the concrete promenade, was raised to +21.4 NAVD88 in the Director's Report. Thus, as shown in Figure 14 and Figure 15, the overall structure elevation recommended in Director's Report (+21.4 ft NAVD88) is unchanged by the currently proposed design changes.



10% CONCEPTUAL DESIGN AND SUBJECT TO CHANGE. NOT FOR CONSTRUCTION

Figure 14 PED (2021) Double row of Sheet Pile (DSP) Section in Boardwalk Reach from Miller Field to Fort Wadsworth

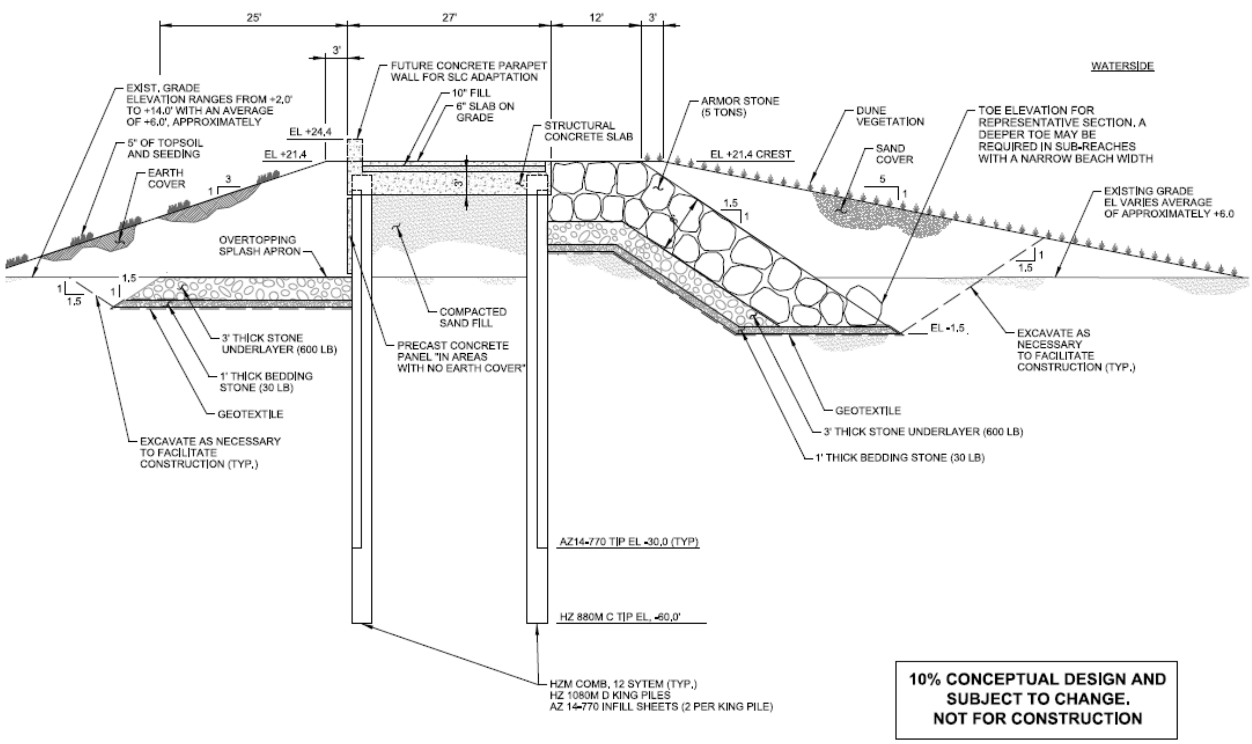


Figure 15 PED (2021) Double row of Sheet Pile (DSP) Section in Promenade Reach from Oakwood Beach to Miller Field

It is also worth noting that the possibility of a different design section for the buried seawall was already considered in the feasibility study. Specifically, the buried seawall design that was part of the alterative originally selected in the 2016 Director's Report (Alternative #4) as the Tentatively Selected Plan already included a short 170-foot section of double sheet pile wall and that the NED Plan also included modifications to the typical, trapezoidal, rock seawall design near Sand Lane where the rock slope landward of the structure crest was replaced by a combination wall comprised of steel H-piles and steel sheet pile. Overall, the DSP section reduces the amount of rock in the updated BRS section, while increasing the amount of steel required. More importantly, the overall cost of the seawall structure is reduced relative to the updated BRS section.

Change in Geotechnical requirements

Feasibility Stage: At the feasibility stage, 14 soil borings and accompanying laboratory testing were performed in October 2002 by Matrix Environmental. The boring depths ranged from 24 to 30 feet. To supplement these borings, an additional 20 test borings, located primarily in the wetland areas, were obtained from New York City Department of Environmental Protection (NYCDEP). The borings were performed by various New York City agencies between 1949 and 1966, some predating construction of the Oakwood Beach wastewater treatment plant (WWTP), mostly concentrated in the footprint of the WWTP, in anticipation of its construction. From these borings a continuous six-foot-thick clay layer, varying between 1 to 10 feet below the *present* ground surface, was identified commencing a short distance south of Grayson Avenue to just west of Kissam Avenue. About 70% of this continuous identified clay layer is located within either the levee segment or floodwall segment with only about 30% or 1500 feet falling beneath the seawall segment. In addition, three localized clay layers were identified along the project alignment: near Tysens Avenue, near Naughton Avenue, and east of Seaview Avenue.

At that time the remainder of the project was assumed to consist of coarse-grained to fine-grained sand with varying amounts of clay, silt, and gravel. The intermediate and deep clay layers were generally not identified at this time due to the limited depth of the borings. Analysis performed at that time, for typical sections, included slope stability of the levee and buried rock seawall; seepage analysis for the levee, floodwall and buried rock seawall; and settlement analysis for the Levee. At that time the extent of contamination and radioactive waste was not as well known, and as with all civil works projects, were considered to be the responsibility of the non-federal partner to provide a clean the site prior to the project being implemented. Since the floodwall was to be constructed on a pile foundation that penetrated through the identified clay layer and the buried rock seawall was to be primarily constructed in an area thought to comprise coarse sand and gravel, settlement was not a major concern and thus analysis was not performed for these features.

In accordance with USACE design manuals EM 1110-2-1913 and EM 1110-2-1902, slope stability analyses were performed for Levee and Buried Seawall sections, along the project alignment for four loading conditions as follows: end of construction (land-side slope); steady-state seepage from full flood stage (land-side slope); sudden drawdown (water-side slope); and earthquake (land-side slope). A commercially available computer program, SLOPE/W, was used to perform the slope stability analyses. The slopes met the minimum acceptable factor of safety, so long as soft organic soils will be removed during construction and backfilled with competent soils. Details on the results of the analysis can be found in the Geotechnical appendix/attachment.

Seepage analyses were performed using the commercially available finite element method (FEM) software program SEEP/W. In order to perform the seepage analyses, a representative cross section was selected for each type of structure. These representative sections were conservatively selected at maximum height locations. Settlement analysis performed for the levee section assuming the soft organic clay layers were removed and back filled since, as discussed above, this is necessary to achieve the necessary factor of safety for slope stability. This assumption was predicated on the clay layers being near the surface and did not consider the presence of the contaminated materials. The immediate settlement values were estimated as per EM 1110-1-1904 predicated on that assumption due to the limited soil information at the time. Accordingly, the estimated immediate settlement values approximately range from ½ inch to 1½ inches. Since most of the estimated immediate settlement is likely to occur during construction, it was determined - at the time of the feasibility study – that long-term primary compression (consolidation settlement) should not be a concern after removing any soft organic soil layer that could be present near the ground surface because the subsurface soils are generally sandy soils (based on the soil data available at the time).

For the floodwall it was determined necessary to support the foundation on piles due to the lateral wave and hydrodynamic forces and thus the surface organic clays near the surface were not critical and settlement was not an issue. Based on the subsurface conditions and driven pile capacity analyses, it was recommended that HP14x89 friction piles be driven into the sandy stratum. This meant that pile tips (bottoms) would be bearing on sand and not clay.

PED Stage:

Additional subsurface investigations were conducted between August of 2018 and August of 2020. The additional field data includes 38 additional Drill Holes (DHs) [also known as test borings or boreholes]; 51 Seismic Cone Penetration Test (SCPTus); and 27 Dilatometer Test (DMTs). The collected data is distributed as follows:

1. Levee Segment: Four DHs, with depth of 36 to 134 ft.; 13 SCPTus, with depth of 12 to 119 ft. and generally over 90 ft deep; and 2 DMTs 50.5 ft. deep.
2. Floodwall Segment: Five DHs, with depth of 81.5 to 134 ft.; 4 SCPTus, with depth of 82 to 94 ft.; no DMTs
3. Seawall Oakwood Beach WWTP- Miller Field Segment: Thirteen DHs, with the majority at 36 ft deep with three at or greater than 135 ft deep; 13 SCPTus, generally 42 to 55 ft. deep, and one at 129 ft. deep; 12 DMTs, with depth of 36 ft. and the majority at 50 ft.
4. Seawall Midland Beach- Ft. Wadsworth: Sixteen DHs, with depth of 36 ft. with one at 46 ft.; 21 SCPTus whose depths were generally 50 to 96 ft. with two over 100 ft. deep; 13 DMTs generally 50 ft. deep.

The added geotechnical data refined the soil profiles for the various construction segments, and the added borings/ CPTs clarified (thickness and strength) the soft clay strata near the surface that presented short- and long-term settlement concerns. The new data showed that clay layers were more extensive and present deeper than feasibility phase borings indicated. In addition, during the time between the feasibility stage and the PED stage, the contamination of Great Kills Park became better defined. As a result, changes to the original design were made to limit excavation within the contaminated area of Great Kills Park known as Operable Unit 1 as well as steps were taken to address the settlement concerns along the project alignment associated with the soft clays encountered.

Addressing the settlement concerns for the levee segment was accomplished by increasing the elevation of the constructed levee by 0.8 feet to allow for long-term post-construction settlement while maintaining the design height over the project life. This was also combined with the use of staged construction of the earthen levee using between one and three lifts (stages) with time allowed (three months) between stages; this would allow the subsoils (soft clays) to gain strength to avoid a shear failure before the next stage would be placed.

In addition, to rapidly stabilize an access way for construction of the tide gate where some of the soft clay layers occurred near the surface, Deep Mixing Methods (DMM) have been incorporated into the design. The DMM panels are 3 feet in diameter with 9-inch overlap running perpendicular to the alignment at 7.5

feet on-center under the levee from a point about 162 feet north of the tide gate and extending south of the tide gate 611 feet to almost the floodwall, for a total of about 770 feet. The use of DMM would provide stable access way to construct the tide gate, and also allows the earthen levee to be constructed in one stage without a concern for shear failure after the tide gate is constructed.

For the floodwall segment: The wall is constructed on friction piles that would penetrate through soft clay layers and no special treatment was required.

For the seawall segments the primary design change between the feasibility study and PED stage was the need to address settlement issues associated with the above-mentioned soft clay layers.

Oakwood Beach to Miller Field. For the buried rock seawall from Oakwood Beach to Miller Field a 60% Design was performed for settlement. The settlement was estimated at the center and at the toe of buried rock seawall in the area of the proposed flood wall and approximately 1,000 feet from the beginning of the seawall.

The settlement will be a result of immediate settlement and primary compression settlement caused by the consolidation process - of the clayey soils - that will occur due the construction of the proposed Seawall. Because the promenade is constructed at grade along the top of the buried rock seawall it is important to limit the settlement caused by primary and secondary compression to avoid cracking and trip hazards. Once the seawall is built to full height, total settlement is estimated at 11.1 inches at the center of the seawall and 5.3 inches at the toe of seawall, assuming that the upper 5 feet of subgrade will be over-excavated and replaced with competent (dense) material. If the seawall is constructed and allowed to sit with no ground improvements, the immediate settlement will occur during the construction of the seawall, and it will take approximately 24 months for 90% of the primary compression (resulting from the consolidation process) to be completed. This would leave 0.8 inches and 0.3 inches of primary compression (consolidation) to occur at the center and toe of seawall, respectively (after the 24-month period). Wick drains were examined as part of the ground settlement improvement program. Installation of wick drains spaced at 5 feet would expedite settlement by 21 months.

For the alternative cross section of the seawall, developed to a 10% design, using the double sheet pile wall, it was assumed that a similar ground improvement using wick drains, spaced 5 feet apart, would be used. Accordingly, no updated settlement analysis was performed. Prior to advancing the design it is anticipated that some additional deep borings will be performed, and “undisturbed” cohesive-soil samples will have consolidation test run on them; this is needed to better identify the clay layers and obtain consolidation parameters for these layers to minimize the limits where wick drains will be required.

Seawall from Midland Beach to Fort Wadsworth. This segment has been limited to a 10% design. The soil borings in this area consisted of no deep borings; however, various borings did encounter clay at “shallow” depths. The soil parameters provided for settlement of the Promenade reach were based on the subsurface conditions developed for the buried rock seawall 60% DDR. The generalized descriptions of the subsurface conditions are based on boring logs, and laboratory test results. No new settlement analyses were performed for this 10% design and the proposed ground improvement program is largely based on work done as part of the detailed design for the buried rock seawall in the Oakwood Beach to Miller Field reach.

The proposed solutions presented in this section are subject to refinement once additional subsurface information is obtained, and additional detailed calculations are performed for each of the proposed cross-sections.

(9) Relative Sea Level Change and Adaptation.

The South Shore of Staten Island Project has been developed with consideration of climate change, and specifically relative sea-level change (RSLC), per ER 1100-2-8162. The plan developed in the feasibility study was formulated based upon the low rate of RSLC but considered the need to adapt the project to account for rates of RSLC that exceed the low rate. As such, the plan was designed so that the major structural components could be adapted, including the seawall, T-wall structure, and levee. These features were specifically designed, so that the structures could be raised in the future to accommodate increases in RSLC greater than planned for in the initial design. The project specifically accounted for 0.7 ft of RSLC (based on the low rate) in the design but considered that under the high rate of RSLC water elevations could increase up to 2.6 ft over the 2022-2072 economic period of analysis considered in the feasibility study. The updated design has similarly been developed to allow for the project to be modified in the future to account for increased water elevations and considering an updated 50-year period of economic analysis (2032-2082) and 100-yr adaptation horizon (2032-2132).

In the Director's Report, it was stated that when the measured RSLC exceeds 0.7 ft, that modification of the project would be undertaken so that the project would continue to provide a robust level of risk management for higher rates of RSLC. This included the construction of a 3- ft high parapet wall along the length of the seawall, extending the height of the T-wall structure by 3 feet, and increasing the height of the levee by 3 feet. The foundations for these structures have been designed to account for this future modification, including the increased loading. The Director's Report also acknowledged that increased RSLC could impact the long-term stability of the beach, and that measures could be needed in the future to address this.

This validation report recommends similar RSLC adaptations, with some refinements, based upon the design efforts, to date. The double sheet pile wall feature has been designed so that a concrete parapet wall can be retrofitted to the top of the structure in the future. In order to accommodate this parapet wall, the initial design of the double sheet pile wall considers the loads associated with future relative sea level change. A reinforced concrete parapet wall and base constructed atop the crest of the buried seawall would raise the crest height of the structure by up to 3 feet. The parapet wall and base would be aligned with the landward edge of the structure. However, the cost of the parapet wall is not currently included in the Validation Report cost estimate, and these details are presented for informational purposes only at this time. When the trigger condition is met, USACE would seek additional authorization in a future decision document to modify the project as described.

RSLC Performance and Adaptation

The recommended/authorized SSSI project optimizes NED benefits over a 50-year period of economic analysis by reducing the risks of flooding associated with a coastal storm that produces a 0.33% AEP still water level under low sea level change conditions (approximately 0.4% and 1% AEP under intermediate and high scenarios as shown in Table 6 below). This design level of performance requires maintaining wave overtopping discharges over the coastal storm risk management (CSRM) alignment below selected wave overtopping thresholds and resisting hydrostatic and wave forces associated with the design water level and wave conditions.

USACE North Atlantic Coast Comprehensive Study (NACCS) water level and wave data (USACE ERDC, 2015) have been used during the Pre-Construction Engineering and Design (PED) phase to characterize coastal storm conditions. As a representative example, expected (mean) extreme water level and significant nearshore wave height values at Midland Beach (NACCS Save Point 11731), including values used for the economic level of performance (0.33% AEP under low RSLC) in the Director's report, are summarized in Table 6 below.

Table 6 Extreme Water Levels and Waves at NACCS Save Point 11731 (USACE-ERDC, 2015)

Annual Exceedance Probability (AEP)	Still Water Level Note 1 (FT, NAVD88)	Significant Wave Height (Hs) (FT)
10%	7.6	8.1
2%	10.0	9.5
1%	11.3	10
0.50%	12.8	10.6
0.33%	**13.8**	**11.0**
0.20%	15.0	11.4
0.10%	16.8	12.1
Note 1: In year 1992 corresponding to the midpoint of the current National Tidal Datum Epoch of 1983–2001.		

Sea Level Change (SLC)

Historic information and local MSL (mean sea level) trends used for the SSSI Project Area are based on data provided by the USACE Sea Level Tracker (https://climate.sec.usace.army.mil/slr_app/) using the tidal gauge at Sandy Hook, New Jersey (Station #8531680). Data used in calculations for Sea Level Change are pulled from the NOAA Center for Operational Oceanographic Products and Services Application Programming Interface (CO-OPS API). Figure 16 below shows historical data at Sandy Hook, NJ, including the monthly average MSL and a long-term linear trend, as well as USACE SLC projection curves. While the monthly means show seasonal and year-to-year variability, the long-term trend indicates about a foot of SLR over the last century. Tidal datums including Mean Sea Levels are typically computed over 19-year periods referred to as a "tidal epoch," and projections of future trends with SLR are made based on the expected trend of the 19-year average. Analysis of recent trends shows some acceleration in the trend of observed sea level rise since 1992, which appears to track somewhat higher than the USACE Intermediate projection curve.

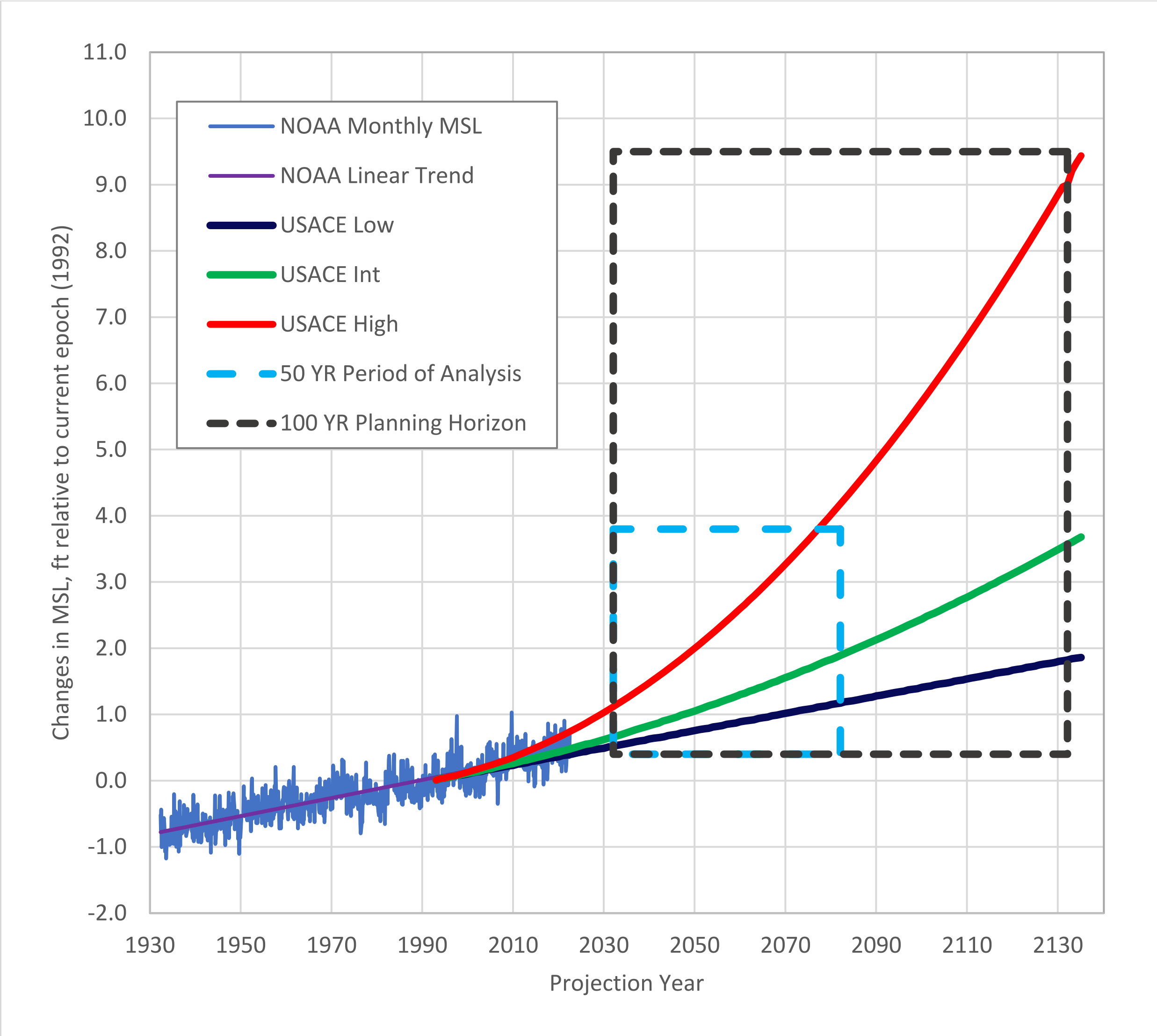


Figure 16 Historical and Projected SLC Trends at the Sandy Hook, NJ

As part of the feasibility study, alternatives were formulated and evaluated for a range of possible future local relative sea level change rates per USACE guidance (ETL 1100-2-1 and ER 1100-2-8159). In the feasibility study, the current SSSI CSRM plan was justified over the 50-year economic period of analysis. However, the SSSI project will remain in service longer than that. Therefore, a project adaptation horizon of 100 years has also been considered consistent with EP 1100-2-1, ER 1105-2-100, and ER 1110-2-8159. An updated 50-year economic analysis period (2032-2082) and 100-year planning horizon (2032-2132) are also highlighted in Table 7. Estimated Relative Sea Level Change values from 2032 to 2132 (Adaptation Horizon) are also summarized in Table 7 below.

Table 7 Estimated Relative Sea Level Change (FT) from 2032 to 2132 (8531680, Sandy Hook, NJ)

Year	USACE Low	USACE Int	USACE High
2032	0	0	0
2042	0.13	0.21	0.46

Year	USACE Low	USACE Int	USACE High
2052	0.26	0.44	1
2062	0.39	0.68	1.61
2072	0.52	0.95	2.3
2082	0.65	1.23	3.06
2092	0.78	1.53	3.9
2102	0.91	1.85	4.8
2112	1.04	2.18	5.79
2122	1.17	2.53	6.84
2132	1.3	2.9	7.98
NOAA's Regional Rate: 0.01302 feet/yr			

Extreme water level statistics for 1992 (current tidal epoch), base year (2032) and the future end of the economic period of analysis (2082) and adaptation horizon (2132) are also summarized in Table 8 and Table 9 below. Note that base year (2032) estimates include an estimated change in MSL of approximately 0.7 ft between 1992 and 2032. This change is based on Intermediate SLC projections which follow the current observed trend closer than the Low SLC projections according to the USACE Sea Level Tracker tool.

Table 8 Base Year and Future (2082) Extreme Water Levels (FT, NAVD88)

Annual Exceedance Probability (AEP)	1992	2032	2082 Low SLC	2082 Int SLC	2082 High SLC
10%	7.6	8.3	8.9	9.5	11.3
2%	10.0	10.6	11.3	11.9	13.7
1%	11.3	11.9	12.6	13.2	15.0
0.50%	12.8	13.5	14.1	14.7	16.5
0.33%	**13.8**	**14.5**	**15.1**	**15.7**	**17.5**
0.20%	15.0	15.7	16.3	16.9	18.7
0.10%	16.8	17.5	18.1	18.7	20.6

Table 9 Base Year and Future (2132) Extreme Water Levels (FT, NAVD88)

Annual Exceedance Probability (AEP)	1992	2032	2132 Low SLC	2132 Int SLC	2132 High SLC
10%	7.6	8.3	9.6	11.2	16.2
2%	10	10.6	11.9	13.5	18.6
1%	11.3	11.9	13.2	14.8	19.9
0.50%	12.8	13.5	14.8	16.4	21.4
0.33%	**13.8**	**14.5**	**15.8**	**17.4**	**22.4**
0.20%	15	15.7	17.0	18.6	23.7
0.10%	16.8	17.5	18.8	20.4	25.5

Figure 17 depicts the change over time in the 0.33% AEP SWL associated with the three different SLC scenarios. The figure also shows the design water level (horizontal blue line at +15.1 NAVD88) which accounts for the Low rate of SLC over the 50-year period of economic analysis (see Table 8 above). As shown in Figure 17, the AEP of the design water level varies depending on the year and RSLC scenario.

Specifically, +15.1 ft NAVD88, which has a 0.2% AEP in the base year (2032), corresponds to 0.3%, 0.4% and 1% AEPs under low, intermediate, and high RSLC change conditions in 2082 (end of the economic period of analysis). The same water level corresponds to 0.4%, 0.9% and 25% AEPs under low, intermediate, and high RSLC change conditions in 2132 (end of the 100-yr adaptation horizon).

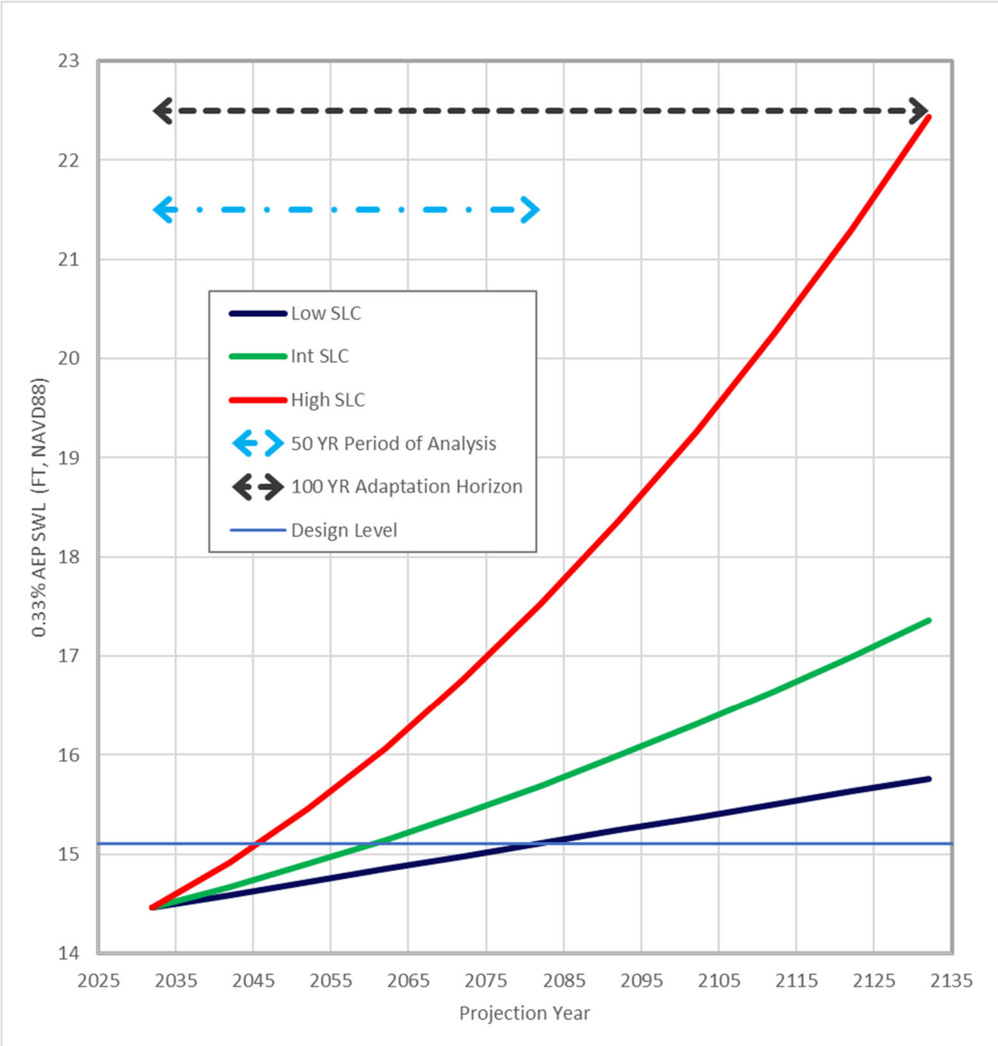


Figure 17: Future changes in design water level (0.33% AEP) for three SLC scenarios

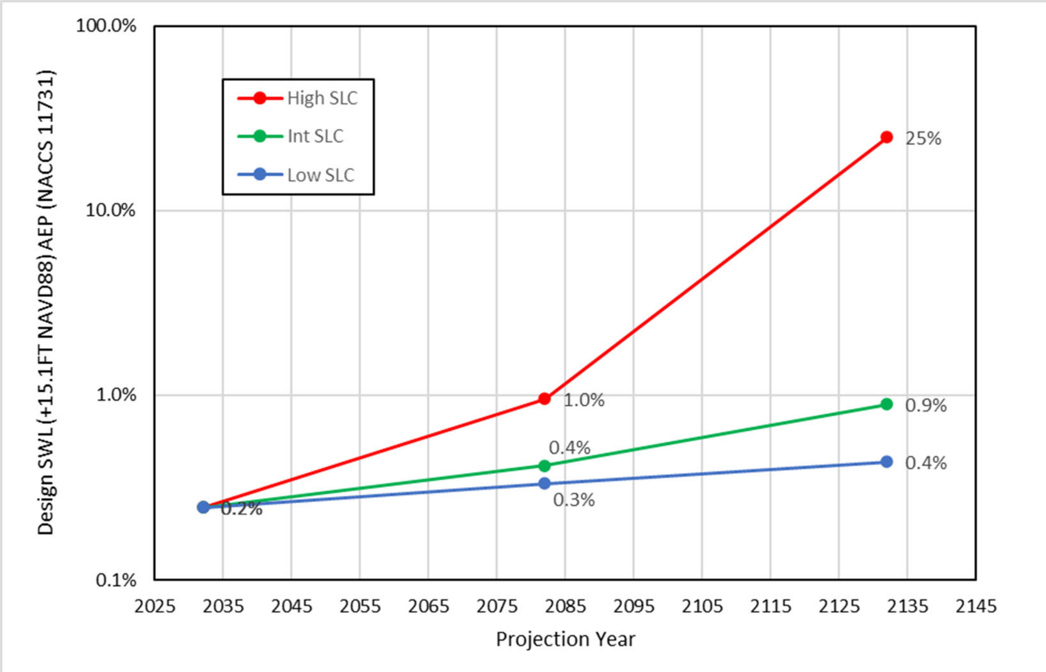


Figure 18: Future changes of design water level AEP for three SLC scenarios

Adaptation to Sea Level Change (SLC)
Given the uncertainty in future mean sea levels, a sensitivity analysis was performed as part of the feasibility study for intermediate and high SLC rates to determine the potential effects on the plan selection Part of this analysis included developing structural adaptation strategies for higher rates of sea level change by raising the CSRM features' crest and/or top of wall height, without the need to rebuild the structures or significantly expand their footprint. Specifically, a reinforced concrete parapet wall and base was proposed atop the crest of the buried seawall which would raise the crest height of the structure by up to 3 feet. In addition, the concrete vertical floodwall around the Oakwood Beach Wastewater Treatment plant would accommodate sea level change by raising the top of wall height. It was assumed that the foundation of the seawall and concrete floodwall would be designed and constructed during the initial construction to counteract future hydrostatic and wave forces. Finally, raising the earthen levee by up to 3 feet by adding impervious and selected backfill to the same lines and grades of the initial construction was also proposed.

It should be noted that existing land elevations rise rapidly at both LOP tie-in areas (seawall near Fort Wadsworth and levee near the intersection of Currie Avenue and Hylan Boulevard). Therefore, there will not a be significant change in project length to accommodate the proposed 3 ft increase in LOP crest elevation.

Figure 19 presents an example of future project adaptation triggers and functional capacity evolution for the seawall section in terms of Annual Exceedance Probability (AEP) for the seawall overtopping design threshold (50 l/m/s). This approach accounts for uncertainty in future sea level change, the effect of deeper water on depth-limited design wave conditions, and future shoreline erosion. Specifically, controlling water depth at the 0.33% AEP design level increases from 4.5 ft (2032) to 14.4 ft (2132 under High SLC) based on a typical beach berm elevation of +8 ft NAVD88. It is noted that based on analysis completed as part of the feasibility study, including SBEACH modeling, it was determined that beach erosion is not anticipated to lower the controlling berm elevation or in general affect the performance of the seawall unless it reaches a minimum beach width of 75 feet (measured from MHW to the seaward toe of the seawall). Representative beach widths are assumed to range from 220 ft initially to 150 ft at the end of the adaptation horizon in 2132, approximately. However, the long-term beach erosion rate may be affected by climate variability, including increasing sea level rise and frequency/duration of coastal storm events. In addition, there are locations along the seawall alignment where beach widths may be narrower than 75 ft in the future. Therefore, as recommended in the feasibility study, beach maintenance and restoration activities may have to be evaluated as a part of future project adaptation, if beach erosion accelerated to the extent that a minimum beach width to 75 feet cannot be maintained.

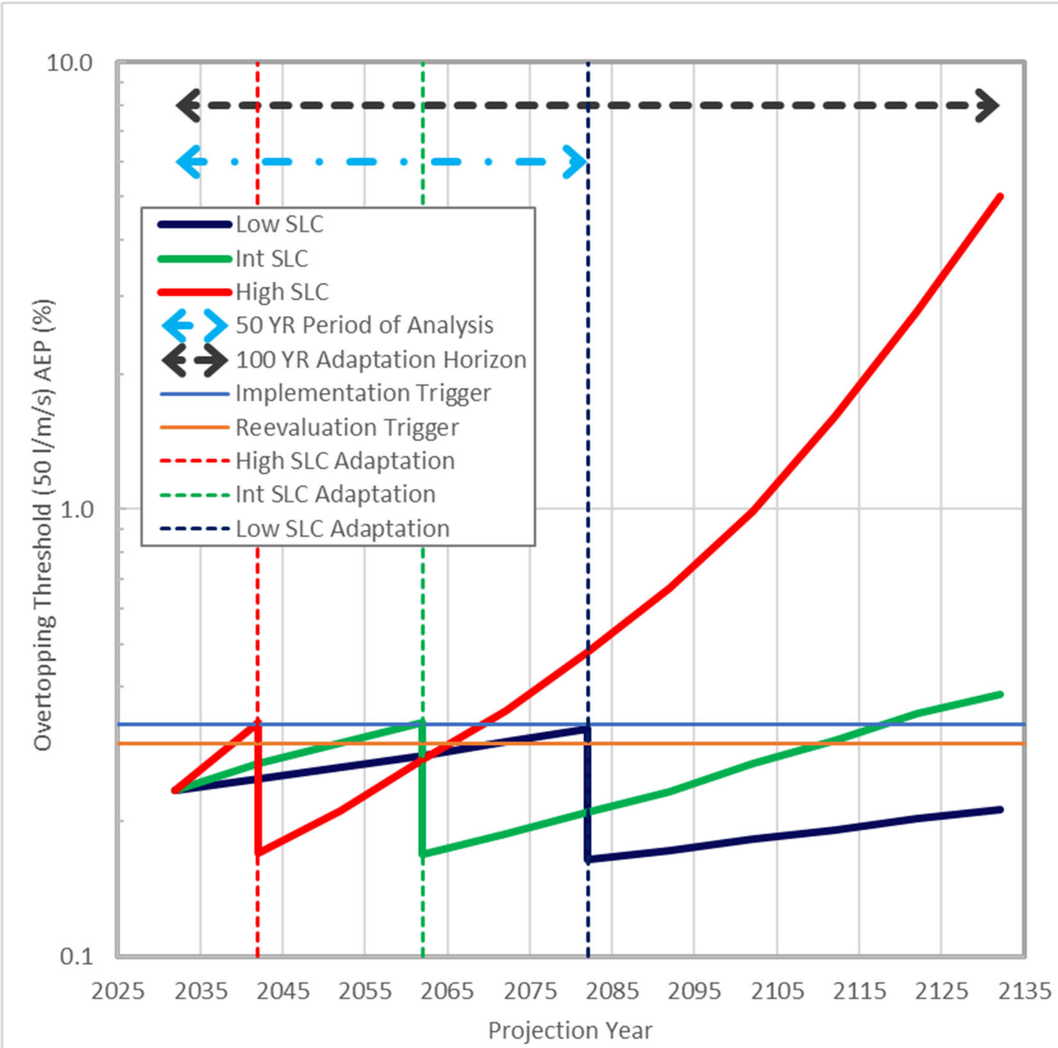


Figure 19: SLC Adaptation for seawall section based on wave overtopping discharge

The blue line in Figure 19 shows that the initial project construction elevation (+21.4ft NAVD88) would maintain functional capacity (overtopping discharge below 50 l/m/s threshold) at the optimum design level (0.33% AEP) over the economic period of analysis (2082) and well beyond the adaptation horizon (2132) after adaptation is implemented. Similarly, the red and green lines in *Figure 19*show how proposed adaptation strategies would maintain functional capacity at the design level over most of the economic period of analysis (until 2070, approximately) for High SLC and over most of the adaptation horizon for Intermediate SLC (until 2120, approximately). On the other hand, High SLC conditions (red line) would gradually reduce the level of functional performance to approximately 5% AEP in 2132 despite adaption.

Figure 19 also illustrates approximate adaptation triggers based on overtopping AEP evolution. For example, under Low SLC conditions the seawall crest elevation would not have to be raised until approximately 2082. On the other hand, under High SLC conditions the seawall crest elevation would need to be raised as early as 2042. For Intermediate SLC conditions adaptation would be required in 2062, approximately. Additional analysis and reevaluation would be required prior to implementing the adaptation measures, therefore Figure 19 also illustrates approximate reevaluation triggers based on AEP of the design overtopping threshold (50 l/m/s) exceeding 0.3%. As shown in Figure 19 this reevaluation trigger would be 5 to 10 years prior to the actual adaptation trigger which should provide ample time for analysis, reevaluation and implementation of the adaptation measures.

(10) Changes in Total Project First Costs.

A series of costs are provided below. These costs are provided for four purposes: 1) to demonstrate that the double sheet pile structure is more cost-effective than the buried rock seawall structure, 2) to demonstrate the incremental justification associated with the double sheet pile wall increase in the project height from +19.4 ft NAVD88 to +21.4 ft NAVD88, 3) to document the changes in the project costs from the Director's Report to the current estimate, and 4) to provide an updated cost estimate to support a new authorization. Note, for this Validation Report three iterations of cost-estimates were undertaken. A screening-level estimate was undertaken to compare the buried rock seawall structure to the double sheet pile structure, based upon a cross-section design. A more detailed alternative cost estimate was completed with an abbreviated risk analysis (ARA), to compare the cost of the +19.4 ft NAVD88 plan with the +21.4 ft NAVD88 plan. Following this alternative analysis, costs for the recommended plan were developed, and subjected to a cost and schedule risk analysis (CSRA), to develop a cost estimate with the appropriate level of detail for authorization.

Identification of preferred cross-section

Table 10 summarizes the evolution of the cost estimate for the cross-section design from the feasibility phase to the PED Phase. Feasibility study costs for the buried rock seawall (BRS) last presented to Congress are presented in the original FY 2017 price levels in the first column and indexed to FY 2022 price levels in the second column for reference. The PED phase updates the BRS conceptual costs for the reasons outlined in section 8: updated stage/wave data and geotechnical data pointed toward increasing the project height from +19.4 ft NAVD88 to +21.4 ft NAVD88 to meet the level of performance specified in project authorization (0.33% event). Finally, the costs of the double sheet pile (DSP) solution are presented in the table and show that the DSP is the most cost-effective solution to be built at +21.4 NAVD88.

Table 10 Total Costs Comparison (in millions)

	FS (2017)*	FS (2022)*	VALIDATION**	VALIDATION**
	BRS	BRS	BRS	DSP
PROJECT COST	$571.30	$736.98	$1,229.49	$1,049.24

*Project costs updated using the Engineering Cost Record City Cost Index updating FY17 to FY22 by a factor of 1.29.
**Estimates for the Validation were taken from the Alternatives Analysis presentation in 2020 and indexed to FY 2022 using ENR City Cost Index-NYC (FY20-FY22) by a of factor 1.06. The costs are presented at FY22 levels because updating them to FY24 would not change the result of this table.

Identification of preferred structure height.

Having established that the double sheet pile wall was more cost efficient to meet the new height requirement of +21.4 NAVD88 than buried rock seawall concept, the question was raised whether the net benefits would maximize with a double sheet pile wall built to the original height of +19.4 ft NAVD88 rather than the updated height of +21.4 NAVD88. The following presents this analysis, and includes a summary of the economic analysis, which is presented in greater detail in Section 10.

Accordingly, 10% level designs were developed for the DSP concept at the +21.4 NAVD88 height and the +19.4 ft NAVD88 height. These designs and quantities were used as the basis for an abbreviated risk analysis (ARA) of the project costs to identify the risks associated with estimated quantities of material. The risk analysis for contingencies at the 80 percent confidence level were estimated in accordance with U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The results of the ARA show that the +21.4 ft NAVD88 recommended height outperforms the +19.4 ft NAVD88 DSP in terms of risk management (Table 11). The cost savings in building the DSP at +19.4 ft NAVD88 are negated by the possibility of increased residual damages. Additionally, the same concerns about project performance and potential to meet life safety objectives for the +19.4 ft NAVD88 buried rock seawall concept apply to the +19.4 ft NAVD88 DSP. Accordingly, the +21.4 ft NAVD88 double sheet pile wall is the optimum size and building method that maximize net benefits for the SSSI project.

Table 11 Comparison of DSP at +19.4 NAVD88 to +21.4NAVD88 (FY24 PL)

DSP size	First Cost	Annualized Cost	Annualized Benefit	Net Benefit
+19.4 NAVD88	$1,229,261,000	$49,657,000	$57,116,000	$7,460,000
+21.4 NAVD88	$1,317,678,000	$53,354,000	$65,640,000	$12,285,000

<u>Identification of Project Cost to support authorization</u>

A CSRA was conducted for the +21.4 ft NAVD88 DSP to develop a cost estimate suitable for cost certification. The CSRA confirmed a construction duration of 102 months and identified an overall schedule contingency of 157 months, for an overall duration of 259 months. The CSRA was conducted for the recommended plan only because the same schedule risks and cost refinements would similarly affect the +19.4 ft NAVD88 height plan, resulting in a similar first cost increase between $300 - $400 million. The results of the CSRA developed cost are shown in Table 12. Supporting details are provided in Appendix C, Cost Appendix.

Table 12 Total Project Costs

Project Cost	
Project First Cost (Oct 2023 P/L)*	**$2,094,202,000**
IDC (2.75% Interest)	$81,724,000
Total Investment	$2,175,926,000
Annualized Investment*	$78,874,000
OMRR&R	$2,008,000
Total Annual Cost	$80,883,000

*Annualized using FY24 discount rate of 2.75% and 50-year period of analysis. Project first costs include expended costs to date.

Cost Differences

Overall design cost increases are driven by changes made to seawall measures in the Oakwood Beach to Miller Field and Midland Beach to Fort Wadsworth segments. Table 13 shows the increase in construction costs for each feature code and highlights changes to the road raisings and utility relocations drive design cost increases. Note that the distribution of work among the feature accounts changed from the Director's Report cost summary to the Validation Report cost summary. Table 13 is organized by project feature, for ease of comparison. Changes between the two summaries are annotated in the table.

Table 13 Project First Cost Comparison Between Director's Report (FY17) and the Validation Report (FY24) (in millions)

Contract and Feature	Director's Report (2017)	Delta $M (Escalated Director's Report 2017 to PED 2024)	PED (2024) - with Contingency	Delta $MIL (Escalated Director's Report 2024 to PED 2024)
1. Levee, Hylan Closure Gate, Tide Gate, and Interior Drainage A				
Lands and Damages (Note 5-1)			$6.4	$6.4
Subtotal Levee, Tide Gate and Interior Drainage A	**$15.8**	**$22.7**	**$78.7**	**$56.0**
2. Floodwall at Oakwood Beach WWTP				
Lands and Damages (Note 5-1)			$1.4	$1.4
Subtotal Floodwall at Oakwood Beach WWTP	**$18.3**	**$26.4**	**$71.8**	**$45.4**
3. Seawall from Oakwood Beach to Miller Field, Interior Drainage Area B and Tidal Wetland				
Lands and Damages (Note 5-1)	$16.9	$23.5	$28.5	$5.0
Seawall w/Promenade	$109.8	$158.5	$436.3	$277.8
Ramps (Note 5-3)	$0.6	$0.9	$21.6	$20.7
Service Road including bridging (Note 5-4)	$5.5	$7.9	$95.2	$87.3
Tidal Wetland	$10.6	$15.3	$24.2	$8.9
Sanitary Sewer Chambers (Note 5-5)	$2.8	$4.0	$12.2	$8.2
Interior Drainage Area B with Tide Gates, Culverts, and Outfall Structures (Note 5-6)	$20.6	$29.8	$153.5	$123.7
OTHER (See Note 2)	$3.6	$5.2	$0.00	-$5.2
Subtotal Seawall from Oakwood Beach to Miller Field, Interior Drainage Area B and Tidal Wetland	**$170.4**	**$245.0**	**$771.5**	**$526.4**

Contract and Feature	Director's Report (2017)	Delta $M (Escalated Director's Report 2017 to PED 2024)	PED (2024) - with Contingency	Delta $MIL (Escalated Director's Report 2024 to PED 2024)
4. Seawall from Midland Beach to Fort Wadsworth and Interior Drainage Area D				
Lands and Damages (Note 6-1)	$25.8	$35.8	$8.4	-$27.4
Relocations (excl. new boardwalk) (Note 6-2)	$12.7	$18.3	$55.6	$37.3
Seawall	$126.2	$182.1	$396.8	$214.7
Boardwalk (all timber number is based on FS) (Note 6-4)	$26.4	$38.2	$21.9	-$16.2
Ramps and Stairs (Note 6-5)	$1.7	$2.5	$51.4	$48.9
Outfalls (Note 6-6)	$9.8	$14.2	$65.7	$51.5
OTHER (See Note 6-7)	$8.6	$12.3	$6.7	-$5.6
Interior Drainage Area D (Note 6-8)	$2.5	$3.7	$0.00	-$3.7
Subtotal Seawall from Midland Beach to Fort Wadsworth and Interior Drainage Area D	**$213.8**	**$307.2**	**$606.7**	**$299.5**
5. Interior Drainage Area C				
Lands and Damages (Note 3-1)			$41.3	$41.3
Subtotal Area C	**$34.7**	**$50.1**	**$117.6**	**$67.6**
6. Interior Drainage Area E				
Lands and Damages (Note 4-1)			$6.5	$6.5
Subtotal Area E	**$17.8**	**$25.7**	**$101.6**	**$75.9**
7. Miller Field Offset				
Lands and Damages (Note 4-1)			$0.9	$0.9
Subtotal Miller Field Offset	**$0.9**	**$1.3**	**$2.9**	**$1.5**

Contract and Feature	Director's Report (2017)	Delta $M (Escalated Director's Report 2017 to PED 2024)	PED (2024) - with Contingency	Delta $MIL (Escalated Director's Report 2024 to PED 2024)
PED (Design phase, develop contract plans/specs/packages)	**$57.9**	**$84.7**	**$167.8**	**$83.1**
Construction Management (Corps S&A, E&D, Mgt during project construction)	**$30.0**	**$43.9**	**$176.4**	**$132.5**
OVERALL PROJECT TOTAL	**$559.6**	**$807.0**	**$2,095.0**	**$1,287.9**

NOTES

Notes
1. Costs from Feasibility phase MII
2. Contingencies: Feasibility level: 32.9%, PED: ranges from 16 (lands & damages) to 47% (construction)
3. CWCCIS Factor 2017Q1 – 2023Q1: - CWCCIS Dated 03/2023, FY23 to FY24 Escalation Rate of 1.39. CWCCIS Rate from Q1 FY23 to Q1 FY24 - (Average of Accounts 2, 8, 10, 11,15,16, 18, and 19) - Because used average, the cost may be slightly different from the TPCS values. FY23 to FY24: 1.037

Notes 1-1 to 1-5

1-1: PED24 (Includes Stripping as well as optional Stripping, also include Phragmites Contaminated Waste Removal)

1-2: PED24 (Includes Seeding, Soil for Earthwork, Topsoil, Crushed Stone, Levee Top Access way, Deep Mixing Method, Cement Bentonite)

1-3: (Includes Relocation, Pipe Removal, Demo Headwall, Vehicular Gate, Instrumentation and Monitoring, For FY24 - Also include concrete work, steel work, drainage swales, and PVC Pipe)

1-4: PED24 (Includes Road Closure Gate in lieu of Road Raising)

1-5: PED24 (Includes Mob/Demob for all except Hyland Blvd Gate + Liability Insurance)

Notes 2-1 to 2-4

2-1: PED24 Includes Clearing and Grubbing and Soil Stripping - Include Optional Stripping

2-2: PED24 Includes Phragmites Material Removal, + Material Associated with Levee Work
2-3: PED24 Includes Deep Mixing Method
2-4: Includes Additional Levee Pertaining Work, Clean Fill for the Levee, Optional Drainage Structure 3A, Topsoil and Seeing associated with Levee work + overall Floodwall Project

Notes 3-1 to 3-4
3-1: PED24 RE for Area C Now Available (Includes Potential Additional Property Acquisition)
3-2: PED24 No Longer Applicable
3-3: PED24 Includes Landscaping and Erosion Control + Disposal of Phragmites Infected Soil
3-4: PED24 Includes Guiderail and Matting to perform Earthwork

Notes 4-1 to 4-3
4-1: PED24 RE for Area E Now Available
4-2: PED24 Includes Landscaping and Erosion Control + Disposal of Phragmites Infected Soil
4-3: PED24 Addressed Not in FS17
4-4: PED24 Includes Relocation, Gravel Road and Matting to perform Earthwork

Notes 5-1 to 5-5
5-1: PED24 (RE Cost Updated and Broken Down and Assigned Separately to Different Contracts that previously was lumped under here at FS16)
5-2: PED24 (New Design/Scope)
5-3: PED24 (New Design/Scope)
5-4: PED24 (Added Scope)
5-5: PED24 (Include Relocation and Civil Demolition Items)
5-6: PED24 (Major Quantity and Design Differences + Area B Phragmites Disposal of Waste)

Notes 6-1 to 6-8
6-1: PED24 (RE Cost Updated and Broken Down and Assigned Separately to Different Contracts that previously was lumped under here at Director's Report 2016)
6-2: PED24 (Added Scope)
6-3: PED24 (New Design/Scope)

6-4: PED24 (Includes Expanded Boardwalk, Include Concrete Portion of the Boardwalk Only, Not Same Design as feasibility - No Timber, Perhaps Elements of it Mixed between Ramps/Stairs at feasibility level)
6-5: PED24 (Includes Crossovers, etc. Not Specified under feasibility, Some Elements may have been counted under Boardwalk portion)

6-6: PED24 (Scope Expanded)

6-7: PED24 (Erosion Control and Cultural Resources)
6-8: PED24 (N/A)

Real estate costs were reduced for Interior Drainage Area C as the City of New York had adjusted the scope of work and taken on responsibility for improvements north of Olympia Ave as part of their Bluebelt Initiative. As a result, the required real estate for properties north of Olympia Ave has been removed from the estimate as these costs become the responsibility of the City of New York. Overall, the number of utilities requiring relocation has increased with more information for the project footprint. The double sheet pile wall method has enabled the project to stay largely within the authorized footprint while increasing the height, but there is still a cost increase to the deeper foundation required to support the increased height (as well as future relative sea level change adaptations). The design and construction management costs increased because of the increased construction duration to 102 months (plus up to 157 of schedule contingency for a possible total of 259 months).

(11) Changes in Project Benefits.

Comprehensive Benefits

This section is prepared in accordance with policy directive *Comprehensive Documentation of Benefits in Decision Document* issued by the Assistant Secretary of the Army on 5 January 2021. The policy updates current procedures to ensure the USACE decision framework considers, in a comprehensive manner, the total benefits of project alternatives. Considerations in this section are given to economic (NED and RED), environmental (EQ) and social (OSE) accounts including an assessment of potential life loss.

National Economic Development (NED)

This section describes the updates to NED benefits established for the Director's Report adapted to the current recommended plan. The benefits are presented in a manner similar to the costs to illustrate the changes in benefits from the Director's Report to the current estimate, and to display the incremental increase in benefits associated with an increase in the proposed height. Storm damage reduction benefits were calculated based on comparison of annual damages under the with- and without-project condition using HEC-FDA software. For this Validation effort, the model was rerun with updated economic inputs and site-specific hydrodynamic inputs. Economic inputs include an update to the structure inventory, a price level update, and the new federal discount rate was applied.

Structure Inventory Update

As part of resiliency efforts in response to Hurricane Sandy, the New York State Acquisition for Redevelopment Program offered eligible property owners affected by Hurricane Sandy the opportunity to sell their property to New York State. Future without project assumptions made during the feasibility study phase excluded structures in the floodplain that were eligible for buyout. However, the acquisition program was completely voluntary, and the expected full take-up did not materialize. A desktop review identified nineteen structures that were erroneously excluded, and those structures were added back into the inventory. The desktop review also revealed 107 structures (between stations 567 to 595 within economic reach FWOB-3) that were included in the feasibility study structure inventory but have since been demolished. Those structures are removed from the structure inventory for this validation report.

The Marshall Valuation Service (MVS) extended life method was used to estimate the rate of depreciation to the value of buildings. For the feasibility phase, structures were assigned depreciated replacement values for damage estimation, however, the passage of time does not in itself create an additional need for further depreciation if the property or component is well maintained and functionally sound. A desktop review shows that the condition of structures in the inventory appear representative of the current condition and there appears to be minimal variation in the remaining useful life, therefore, no further depreciation is applied to the depreciated replacement structure values established during feasibility.

Benefits Updates

Table 144 displays the inundation reduction benefits contained in the Director's Report, in FY 2017 price levels and updated benefits to support the recommended changes to the project. Benefits presented here represent changes due to price level and still water elevations. Benefits from the proposed plan of improvement were estimated by comparing damages with and without the proposed measures under existing and future conditions. Columns 1 and 2 show benefits developed for the feasibility effort using still water (SWL) elevations obtained from FEMA Post-Sandy (2013) plus the USACE low relative sea level change (RSLC) change scenario in the original fiscal year 2017 price level and updated to fiscal year 2023 price levels. Columns 3 and 4 display benefits of the plan evaluated against the NACCS SWL for the intermediate rate of RSLC. Estimates of damages reduced over a 50-year period of analysis use, for the feasibility study, FY17 price levels and discount rate of 2.875% and for the validation study, FY24 price levels and the FY24 discount rate of 2.75%

As shown in Table 14 for the feasibility study, annual project benefits were estimated at $30,374,000 (FY 17) and updated to $44,141,000 in FY24 price levels. The recommended plan benefits are $89,275,000 (FY 24) using the intermediate scenario of sea level change. For comparison with the feasibility phase, benefits are shown at the low rate of relative sea level change (RSLC) for both the 19.4 ft and the +21.4 ft NAVD88 crest elevations as well as the intermediate and high rates of RSLC in Table 15.

Table 14 Project Benefits

[1] Director's Report Benefits 19.4 ft height FY 17 Price Level Low Scenario	[2] Director's Report Benefits 19.4 ft height FY24 Price Level Update Low Scenario	[3] Validation Report Benefits 19.4 crest elevation FY24 Price Level Intermediate Scenario	[4] Validation Report Benefits 21.4 crest elevation FY24 Price Level Intermediate Scenario
FEMA	**FEMA**	**NACCS**	**NACCS**
$30,374,000	$44,141,000	$78,928,000	$89,275,000

*All values are rounded to the nearest 1000s.

NED Benefits Sea Level Rise Sensitivity

Average annual benefits for the recommended plan were re-computed using the “low”, “intermediate” and “high” rates of sea level rise. For comparison with the feasibility phase, benefits are shown at the low rate of relative sea level change (RSLC) for both the 19.4 ft and the +21.4 ft NAVD88 crest elevations as well as the intermediate and high rates of RSLC in Table 15.

Table 15 NED Benefits SLR Sensitivity

Benefits			
21.4 ft Plan	**Low**	**Intermediate**	**High**
Project alignment	$56,972,000	$78,710,000	$193,977,000
Boardwalk	$635,000	$681,000	$722,000
Interior Drainage	$9,884,000	$9,884,000	$9,884,000
Total Benefits	$67,491,000	$89,275,000	$204,583,000
Benefits			

19.4 ft Plan	Low	Intermediate	High
Project alignment	$47,866,000	$68,576,000	$170,223,000
Boardwalk	$430,000	$468,000	$498,000
Interior Drainage	$9,884,000	$9,884,000	$9,884,000
Total Benefits	$58,180,000	$78,928,000	$180,605,000

Other Social Effects (OSE)

Life Safety

Hazards and Consequences Hurricane Sandy created enhanced wind speeds and contributed to record setting surge making Sandy one of the largest Atlantic tropical storms ever recorded. The worst flooding occurred along the New Jersey shore and sections of Staten Island facing Lower New York Bay where water heights reached 9.53 feet above Mean Higher High Water. Of the 23 storm-related deaths on Staten Island—more than in any other borough—all but one occurred on the East and South Shores of Staten Island, where there were twenty-three recorded deaths[11], ten of those deaths were in Midland Beach alone.

Staten Island Historical Life Safety Risk Storm surge and wind from the Sandy storm caused deaths both directly and indirectly. Directly caused deaths were attributed to storm surge causing flooding in homes. In addition to storm surge forces, the area saw gusty winds that resulted in downed trees and power lines. Hurricane Sandy caused a massive power outage in the Northeast leaving residents without power for days, even months, after the storm. This led to unsafe conditions where street light outages led to under regulated traffic creating hazardous roads. Power outages also caused the disruption of services for individuals dependent on electrically powered medical equipment such as ventilators and oxygen concentrators. The speed, intensity and duration of the storm was catastrophic in terms of life loss due to a lack of timely evacuation prior to the storm. 68% of residents of low-lying areas were left exposed to coastal storm impacts during and in the aftermath of Hurricane Sandy.

South Shore Staten Island Risk Assessment The proposed South Shore Staten Island (SSSI) Coastal Storm Risk Management project was analyzed by the Risk Management Center (RMC) as a Risk-Informed Design project in 2020. A Semi-Quantitative Risk Assessment (SQRA) was conducted by RMC team members, New York District employees, and other contractors. Additional hydraulic and hydrologic modeling was conducted by the risk assessment team in order to understand how wave over wash could impact the protected area and impact the probability of the project failing. The SQRA considered the levee/floodwall/seawall elevations shown below in Table 166. As shown, the rock seawall elevation analyzed by the RMC was 21.4 ft-NAVD88 or higher.

Table 16 Project Section Elevations

Distance (ft)	Start Station (ft)	End Station (ft)	Structure	Sub-Reach	Structure Crest Elevation (ft-NAVD88)
3392.9	4292.9	4293	Levee	Levee	16.9
1102.9	1521.9	1522	Floodwall	I-Wall	17.4
1691.9	3213.9	3214	Floodwall	T-Wall	19.4
1279.9	2279.9	2280	Rock Seawall	Oakwood Beach West	21.4
2294.9	4574.9	4575	Rock Seawall	Oakwood Beach East	23.4
1804.9	6379.9	6380	Rock	Cedar Grove	23.4

[11] A Stronger More Resilient New York "EAST AND SOUTH SHORES OF STATEN ISLAND" page 271

			Seawall		
1959.9	8339.9	8340	Rock Seawall	New Dorp Beach	23.4
2573.9	10913.9	10914	Rock Seawall	Miller Field	23.4
2869.9	3799.9	3800	Rock Seawall	Midland Beach	21.4
4799.9	8599.9	8600	Rock Seawall	Ocean Breeze	21.4
2999.9	11599.9	11600	Rock Seawall	South Beach	21.4
2674	14274	14457	Rock Seawall	Fort Wadsworth	21.4

SSSI SQRA Without Project Condition (FWOPC) Results Life loss estimation was performed using Hydrologic Engineering Center Loss of Life Simulation software (HEC-LifeSim v. 2.0) to model life risk under inundation scenarios for the existing and future with project conditions. Future without project conditions which are compared to the future without project are assumed to be consistent with existing conditions. For the SSSI study area, daytime and nighttime population at risk (PAR) are shown in Table 177 for several inundation scenarios.

Table 17 Population at Risk

Inundation Scenario	Structures Inundated	Daytime PAR	Nighttime PAR
1-ft OT*	11,084	32,557	38,865
TOL*	10,780	31,181	36,698
100-yr	7,750	15,336	25,479
10-yr	957	1,856	3,069
2-yr	53	90	177

*OT refers to overtopping; TOL refers to top of levee.

Median estimated life loss for the future without project condition under various inundation scenarios with ample warning are shown in Table 188 for both day and nighttime. The ample warning scenario models a coastal storm scenario where hazard identification is set to 24 hours prior to the breach (-24 hours) and people have time some time to plan and respond to the threat. As shown in the table, although people are able to take protective action (i.e., evacuate) expected life loss is still significant for the top of levee (TOL) elevation without project condition. The FWOPC results are used to compare life loss consequences against the future with project condition (FWPC) scenarios.

Table 18 Median Estimated Life Loss for the Future Without Project Condition (FWOPC)

Scenario Name	Daytime Median Life Loss	Nighttime Median Life Loss
FWOPC 1-ft OT	98	85
FWOPC TOL	81	70
FWOPC 100-yr	7	10
FWOPC 10-yr	0	0
FWOPC 2-yr	0	0

Residual Risk Residual flood risk (nonbreach) is the life loss that remains in the floodplain after a proposed flood risk management project is implemented. Table 1919 presents median estimated nonbreach life loss for the future with-project condition (FWPC) under the same inundation scenarios presented for the without project. According to the HEC-LifeSim results, the median percentile of non-breach life loss is 0 (during the day) and 1 (at night) with ample warning for the top of levee (TOL) scenario. With the project in place, life risk is reduced at least one order of magnitude compared to the without project condition.

Table 19 Future With Project Median Life Loss

Scenario Name	Median Life Loss Daytime	Median Life Loss Nighttime
FWPC 1-ft OT	14	17
FWPC TOL	0	1
FWPC 100-yr	0	0
FWOPC 10-yr	0	0
FWOPC 2-yr	0	0

The results indicate that remaining risk is driven by individuals' inability to take protective action. To further reduce risk to life safety, the New York City emergency action plan should be executed. Residual risk is estimated based under the assumption that the project works as designed and is not breached. The real-world possibility is that a storm event could cause the project to fail and therefore it is important to also consider incremental risk.

SQRA Incremental Life Loss To evaluate incremental risk for the with-project condition, the Semi-Quantitative Risk Assessment (SQRA) was performed to determine incremental consequences due to failure of the SSSI coastal storm risk management project (project height of +21.4 ft NAVD88 for Boardwalk and Promenade seawalls). Using methods for failure modes analysis and life loss estimation, breach and non-breach scenarios were identified and compared. A failure mode is a unique set of conditions and/or sequence of events that could result in the sudden, rapid, and uncontrolled release of impounded water (FEMA 2003).

The recommended +21.4 ft NAVD88 double sheet pile seawall will strengthen the resilience of the eastern portion of the south shore of Staten Island against future severe coastal storm surge flooding and wave forces. However, the project to reduce the risk of flooding will not eliminate all flood risk. Storm induced inundation risk scenarios of primary concern for life loss risk are overtopping with no breach and breach prior to overtopping where inundation velocities arrive with little advance warning due to project failure.

Non-breach risk occurs when the flood risk reduction capacity of the levee is exceeded, and flood waters overtop the structure. At this point, the levee transitions from managing the flood to passing the flood. For levees[12], the transition occurs when the flood stage exceeds the levee crest. This elevation corresponds to the annual probability of non-breach inundation but may not result in life loss. The annual probability of flooding with non-breach life loss was estimated to be 1/750 AEP (1.33E-03) based on the top of levee (TOL) elevation (USACE 2021). This event exceeds the design criteria of the +21.4 ft NAVD88 seawall. The SQRA results show that the primary incremental (i.e., breach minus non-breach) risk-driver potential failure modes are wave overtopping of the seawall within the boardwalk reach followed by freeflow (i.e., still water) overtopping of the levee embankment, which occur at flood loading events that exceed design criteria. Table 200 compares breach and non-breach life loss estimates for the ample warning scenario at Breach Location 2 (BL2) (near Midland) of the +21.4 ft NAVD88 height project for the 1000-year event.

[12] Levees refers to a structure that excludes floods in this case the structure is the seawall.

Table 20 Estimated Life Loss for (BL2 1,000-yr) Breach

Statistic	Life Loss for Ample Warning Scenario					
	Breach		Non-Breach		Incremental	
	Day	Night	Day	Night	Day	Night
95th Percentile	38	47	31	42	7	5
75th Percentile	27	33	21	27	6	6
Median	18	21	14	17	4	4
25th Percentile	9	11	6	9	3	2
5th Percentile	1	2	0	1	1	1

SQRA results show there is significant overtopping that could lead to life loss in the non-breach scenarios and that in the event of breach, the incremental life risk will be minimal. This illustrates that the greatest contributor to residual risk is a result of overtopping of the structure during storm events with a surge height that exceeds the levee height. The loading scenarios that are most likely to result in project failure is associated with the 1000-year event. The 1,000-year coastal storm event represents a major storm event that would likely incur ample warning time due to advanced forecasting of this high category storm. It is likely that the majority of the population at risk (PAR) will mobilize in response to an expected mandatory evacuation due to their past experience with Hurricane Sandy.

Risks to life safety in the face of hurricane forces as experienced with Sandy, will be driven by individuals' ability to get out of harm's way, for example, drowning deaths occurred to people who did not get out of the way of fast approaching storm surge. Life safety risk analysis considers public warning issuance, the mobilization rate, and structure attributes in high-risk areas. Almost the entirety of the leveed area is densely developed, which is primarily residential, but there are also important commercial, industrial, and public structures. If a large portion of the PAR evacuates as floodwaters arrive, there is a possibility for vehicles to get submerged or swept away, which would lead to life loss. Most of the modeled life loss in the with-project condition occurs on roads during evacuation rather than in structures. The depth of flooding in the structures is significantly reduced in the with-project condition, but 1 ft of flooding on a roadway can contribute to loss of life.

SSSI SQRA Risk Matrix For the visual representation, the incremental life safety risk matrix is shown in Figure 20 which displays the outcome of the SQRA on the +21.4 ft NAVD88 seawall with annual likelihood of failure on the vertical axis and average annual life loss on the horizontal axis. The weighted average of life loss is estimated for risk-driving potential failure modes (i.e., the ways that the project is most likely to fail and/or result in incremental consequences). Project risk increases as the plotting position moves up and to the right on the graph. The non-breach plot (shaded in green) shows that there is considerable life risk prior to failure and that in this scenario, societal risk is not being properly managed. Societal risk (represented by the dashed line on the plot) is the probability of adverse consequences and risks that plot beyond the societal life risk line are considered unacceptable. For the 1,000-year scenario, breach and non-breach inundation are very similar, resulting in minimal incremental flow, with freeflow overtopping significantly contributing to the non-breach life safety risk. The plot of incremental risk (shown in red) is just within what is considered acceptable to society. There is less incremental life loss compared to nonbreach life loss because incremental life loss is equal to breach life loss minus non-breach life loss. Incremental life loss is not synonymous with breach life loss.

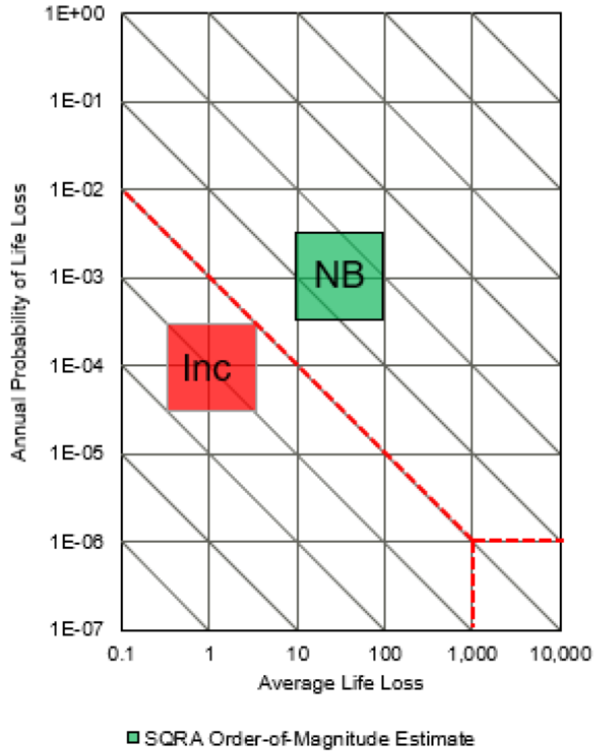


Figure 20 Incremental Life loss plot

The +21.4 ft-NAVD88 recommended height of the seawall will reduce the volumes and velocity of the peril and provide significant life loss risk reduction to the PAR. The residual risk (i.e., non-breach risk combined with incremental risk) is currently plotting relatively high on the risk matrix. If the height of the structure is reduced to +19.4 ft-NAVD88, the non-breach life loss will shift up on the y-axis of the risk matrix (i.e., non-breach life loss will occur more frequently) and incremental risk will also likely shift up on the y-axis somewhat, which could push the incremental risk above of the societal tolerable risk line and the risk management capacity of the structure would be diminished. It's possible that non-breach average life loss could also shift towards the right as more life loss would occur during more frequent events. In other words, lowering the height of the seawall would shift both the non-breach and incremental risk higher on the chart shown above to unacceptable levels, and would increase residual life safety risk significantly.

Qualitative Life Safety Evaluation of Final Array Alternatives To determine if the seawall is the most effective at meeting planning objective of life loss risk reduction compared to other measures in the final array, a qualitative evaluation is performed. This evaluation broadly considers the performance and exposure components of risk based on what is driving the risk to life safety in the area. Risks to life safety is driven by people who remain exposed to the peril. The performance risk component speaks to whether the measure manages flood velocities and exposure informs evacuation rates.

Final Array

The final array consisted of four plans plus the no action plan to include beach fill, partial road raising, full road raising and the seawall. The primary measure for Alternative 1 called for beach fill along the shorefront which required 3.2 million cy (cubic yards) of placement to protect against the 1-percent storm as estimated during feasibility phase plan formulation. Alternatives 2 and 3 required full and partial road raising as the primary measure to manage coastal storms. Alternative 2 required road raising for the entire length of Father Capodanno Boulevard which runs parallel to the shore for approximately 14,000 ft and 6800 ft of armored levee from Miller Field to Oakwood Beach. Alternative 3 is a slight variation of Alternative 2 but called for *partial* road raising of Father Capodanno Blvd. and raising of the existing promenade. The primary measure for Alternative 4 is a seawall to run the length of the study area shoreline from Oakwood Beach to Fort Wadsworth.

Final array life safety considerations are evaluated on how well it reduces life risk by affecting the performance of the system. Corps Engineering Pamphlet, "Guide for Incorporating Life Risk in USACE Flood and Coastal Storm Risk Management and Project Development" (EP 1105-2-63) provides examples of measures and the component of risk that measure primarily impacts. All of the measures in the final array impact performance (manages the velocity of flooding) component of risk[13].

As long as there is an exposed population where people cannot or will not take protective action, risk to life safety will remain. Life safety risk reduction would be further reduced with a project that performs well and works in tandem with plans that reduce exposure. New York City Office of Emergency Management has a robust hurricane readiness plan and provides access to the Hurricane Evacuation Zone Finder tool that allows users to find nearby evacuation centers and identify whether they are located in a high-risk zone.

Critical Infrastructure

Critical infrastructure in the study area include the Staten Island Railway (SIR), schools, utilities, fire and law enforcement stations and the Staten Island University Hospital (SIUH) (see Figure 21). Hylan Boulevard is a major roadway that runs approximately fourteen miles parallel to the shoreline. Hylan Blvd is a commercial corridor that serves local residents and summer visitors[14]. Figure 20 shows storm surge extents for a category 3 hurricane inundation created by the National Hurricane Center (NHC) Storm Surge Unit with the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model. The red color on the map highlights areas within storm surge zones that have the greatest exposure (i.e., surge greater than 9 feet above ground). The blue zones represent less than 3 feet above, and the yellow represents greater than 3 feet above ground, and the orange represents greater than 6 feet above ground. Approximate locations of critical facilities are overlaid onto the hazard zone and shows SIUH, several schools (in green) and a law enforcement station are in high hazard areas.

[13] EP 1105-2-63 does not show these measures as having a primary impact on the following risk components: hazard, vulnerability and consequence.

[14] New York City (2013) A Stronger More Resilient New York: East and South Shore of Staten Island

Figure 21 NOAA Coastal Hazard Map and Critical Facilities for the SSSI study area

These facilities are community lifelines so there were protective actions planned and executed which limited operational impacts during Sandy. SIUH has a campus in the northern part of Staten Island on higher ground where patients were evacuated to during Sandy. Four schools in the hazard zone were impacted, with two remaining closed for almost a month following the storm but students enrolled at those schools were sent to alternative locations. Tottenville High School located outside of the impact area served as an evacuation intake center for affected residents. Hylan Blvd. which lies parallel to the coast and lies in the high-risk area remains at risk of inundation in the future without-project condition. The low-lying road was inundated in many areas during Sandy, causing delays in bus service and businesses on the strip were forced to close for several days. The boulevard is an important road that would need to be crossed in order for people to evacuate to higher ground. If an event makes the road impassable, residents could get trapped trying to escape. Staten Island residents accounted for 5 percent of the citywide resident workforce in 2016 (most recent data available), yet they made up a disproportionate share of the City's firefighters (39 percent), police officers (20 percent) and elementary and middle school teachers (10 percent)[15]. It is necessary that important roadways like Hylan Blvd. are clear and accessible for these first responders to assist when emergencies happen. Also, the SIR which connects residents to the ferry to Manhattan (where more than a one quarter of residents are employed) is another vulnerable facility that remains at risk of inundation. The seawall, designed primarily to resist storm surge along the coast, will protect these critical infrastructure from inundation and provide savings by alleviating human and financial loss.

Socially Vulnerable

[15] Office of the New York State Comptroller, "An Economic Snapshot of Staten Island" Report 7-2019

Certain households in the study area occupy two or more storied structures where occupants are able to escape to upper floors in the event of rising waters. However, those who are aged or have mobility issues would not be able to egress vertically as easily as those who are younger and more agile. Of the deaths that occurred in the area, elderly residents were hit especially hard, with close to half of the people who died being aged 65 or older[16]. Presented in Table 21 is the breakdown of socially vulnerable populations at risk within the study area. The table shows overall populations for several categories in New York State, Richmond County and select US Census tracts representing the floodplain.

Table 21 Socially Vulnerable Population

	New York State		**Richmond County**		**Floodplain**	
	Count	Percent	Count	Percent	Count	Percent
Population	19,276,809		471,599		70,205	
Poverty	2,581,048	13.4%	50,804	10.8%	7,680	10.9%
Under 5	1,140,669	5.9%	27,153	5.8%	3,802	5.4%
65+	3,221,702	16.7%	77,313	16.4%	11,565	16.5%
Black	3,002,401	15.6%	48,623	10.3%	3,594	5.1%
Native	76,535	0.4%	1,149	0.2%	116	0.2%
Asian	1,674,216	8.7%	47,605	10.1%	8,045	11.5%
Hispanic	3,720,707	19.3%	87,733	18.6%	11,210	16.0%

Environmental Justice

Environmental justice (EJ) considerations for the SSSI study are carried out pursuant to the memorandum[17] from the Assistant Secretary of Civil Works dated 15 March 2022, which provides the framework for implementing environmental justice through projects that have been authorized.

As defined by the memo, environmental justice is the fair and meaningful involvement of all people regardless of race, color, national origin or income regarding the development, implementation and enforcement of environmental laws, regulations, and policies, with no group bearing a disproportionate burden of environmental harms and risks. This section examines whether a disproportionate impact as a result of the project accrues to disadvantaged communities within the study area.

Disproportionate burden in the context of the SSSI project refers to the environmental impacts of the project and the distribution of those impacts within low-income and/or minority (disadvantaged) communities. The White House Council on Environmental Quality Climate and Economic Justice Screening Tool (CEJST) was used to understand the potential impacts to the communities in the leveed area. Relevant categories of environmental burden considered for SSSI are Climate Change and Critical Clean Water & Wastewater Infrastructure[18]. Figure 22 below is a map of the study area (bounded by the

[16] New York Times, November 12, 2012, "Mapping Hurricane Sandy's Deadly Toll

[17] Implementation of Environmental Justice and the Justice40 Initiative

[18] USACE CEJST burden categories: **climate change** Tracts ARE at or above the 90th percentile for expected agriculture loss rate OR expected building loss rate OR expected population loss rate OR projected flood risk OR projected wildfire risk; **clean water and wastewater infrastructure** Tracts ARE at or above the 90th percentile for underground storage tanks and releases OR wastewater discharge AND are at or above the 65th percentile for low income.

yellow and orange lines from Oakwood to Fort Wadsworth) to include areas highlighted by the tool for some category of burden.

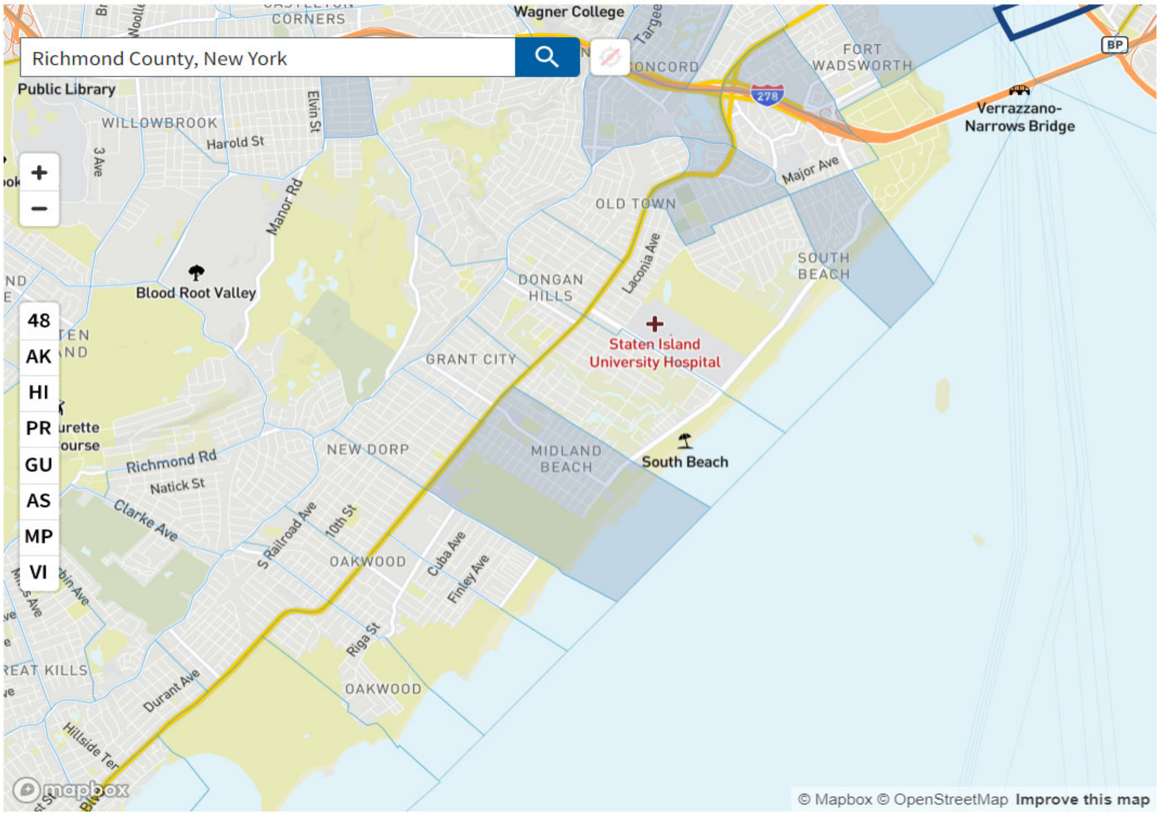


Figure 22: Environmental Justice Map of Disadvantaged Communities in the SSSI Study Area

The CEJST highlights three "problem areas" that warrant further inspection as to whether there is a potential environmental justice issue to a disadvantaged community. In accordance with ASA memo dated 14 March 2023[19], communities identified by the CEJST tool as those highlighted in Figure 20 are considered economically disadvantaged. For a community to be considered disadvantaged on the climate change burden, the tract must exceed the 90th percentile of more than one of the following burden indicators, expected building loss, population loss, projected flood risk, and wildfire risk and also meet the low-income threshold. Similarly, for a tract to be recognized for the wastewater burden the tract would have to meet or exceed the 90th percentile for underground storage tanks and be low-income. Neither of the highlighted tracts meet these criteria.

While a burden exists for the highlighted areas on the map, those areas are not representative of minority, low income or Tribal communities. Referring to the Socially Vulnerable Population table above, US Census estimates show that Black and Hispanic populations in the floodplain are 5% and 16% respectively, well below that of the county and national populations. The Lenape tribe were a sovereign nation on the west side of Staten Island but today that population make up a diaspora[20], less than 1% of residents in the study area identify as Tribal/Native. Tracts in the study area highlighted by the CJEST

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[19] Assistant Secretary of the Army, Memorandum for Commanding General, US Army Corps of Engineers, "Implementation Guidance for Section 160 of the Water Resources Development Act of 2020, Definition of Economically Disadvantaged Community"

[20] https://barnard.edu/news/tour-native-new-york#:~:text=In%20New%20York%20City%2C%20there,make%20up%20a%20diaspora%20today.

tool commonly represent communities with a workforce development disadvantage where occupants exceed the 90st percentile for linguistic isolation and the percent of residents without a high school diploma exceeds the 10% threshold.

Impacts of the project which runs the length of the shore will not accrue to any single tract or population and the project will have beneficial impacts to all populations within the study area by providing storm protection and promoting resiliency to communities in high-risk areas.

Regional Economic Development (RED)

The regional benefit associated with construction is the indirect and induced economic output that would be produced for an assumed construction cost.

Of total expenditures, a portion will be captured within the local impact area and portions will accrue to the state and nation. Direct expenditures capture direct impacts to the area's employment and income based on the goods and services necessary to complete construction of the alternative. Construction will also generate secondary economic activity often called expenditure multiplier effects. This would be realized through consumer spending for example, companies that supply materials or services to companies engaged in construction. It should be noted that the extent of the multiplier effect is dependent upon how consumers respond to the additional income. Also, as the Bureau of Labor Statistics reports, there are other influences on consumer spending habits (aside from changes in income) for example, the onset of the COVID-19 pandemic in 2020 affected spending across 14 major spending categories differently from 2019 to 2020 (BLS 2020).

The USACE certified RECONS input/output model was used to determine the expenditure multiplier associated with the specific work activity of alternatives considered in the final array. The RECONS model assumes 100-percent expenditure impact for all activities in a spending profile therefore, because all categories require labor, the impact on labor spending is used to compare the alternatives.

Table 22 compares the impact on labor due to specific construction activity for the alternatives in final array. The beach fill option is classified under the Construction or Major Rehabilitation of Earth Dams and Spillways which uses MCACES[21] factors for construction of earth dams (MCACES Code 4a) to allocate the costs among construction labor. Beach fill is a fairly labor-intensive project, with construction labor accounting for approximately 17% of project costs. Road raising activities are classified under Construction, Repair, and Major Rehabilitation of Earth, Concrete, and Steel Channels and Canals (does not include dredging). MCACES Code 9b was used to allocate the costs associated with construction labor work activities which accounts for approximately 20% of project costs. The seawall option is classified under Construction and Major Rehabilitation of Earth, Concrete, and Mechanical/Electrical Levees and Floodwalls. MCACES Code 11B was used to allocate the costs among construction labor which accounts for approximately 27% of project costs. The seawall construction activity would add the most to the regional labor economy if costs for each project were the same. There is high confidence that although costs for all of the alternatives in the final array have not been fully developed for this effort, the seawall option remains the least cost solution because inflationary price cost increases would impact each alternative similarly. Being the least expensive cost option could put the seawall at a disadvantage and make the other options more attractive as far as contribution to labor because the more the project expenditures are, costs the more favorable an impact on the regional economy.

[21] Micro-Computer Aided Cost Estimating System (MCACES) is a multi-user software program used by the U.S. Army Corps of Engineers for the preparation of detailed construction cost estimates for military, civil works, and environmental projects.

Table 22 Expenditure Multiplier for Labor

Construction Activity	Impact on Labor
Beach Fill	+17%
Road Raising	+20%
Seawall	+27%

The RECONS software was used to estimate the overall impact of construction expenditures for the seawall alternative based on current cost estimates. Summarized in Table 23 is the predicted impact of the seawall alternative measured in output, jobs, labor income, and gross regional (value added) product. The expenditures associated with construction work activities for the seawall at Richmond County, New York were estimated as $1,671,321,000. The expenditures would support a total of 19,339.2 full-time equivalent jobs, $1,337,261,000 in labor income, $1,419,386,000 in the gross regional product, and $2,149,590,000 in economic output in the local impact area. More broadly, these expenditures support 30,960.1 full-time equivalent jobs, $2,218,423,000 in labor income, $2,765,705,000 in the gross regional product, and $4,602,615,000 in economic output in the nation.

Table 23 Regional Output Summary

Area	Local Capture	Output	Jobs	Labor Income	Value Added
Richmond County					
Direct Impact		$1,285,121,000	14,461.6	$1,055,954,000	$912,840,000
Secondary Impact		$864,469,000	4,877.6	$281,307,000	$506,546,000
Total Impact	$1,285,121,000	$2,149,590,000	19,339.2	$1,337,261,000	$1,419,386,000
New York State					
Direct Impact		$1,485,695,000	16,100.0	$1,213,618,000	$1,074,747,000
Secondary Impact		$1,424,212,000	6,920.5	$525,717,000	$889,814,000
Total Impact	$1,485,695,000	$2,909,907,000	23,020.4	$1,739,335,000	$1,964,560,000
United States					
Direct Impact		$1,625,174,000	17,336.7	$1,266,415,000	$1,140,910,000
Secondary Impact		$2,977,441,000	13,623.3	$952,007,000	$1,624,795,000
Total Impact	$1,625,174,000	$4,602,615,000	30,960.1	$2,218,423,000	$2,765,705,000

Dollar values in the table have been rounded to the nearest thousands.

Environmental Quality
No impacts to threatened and endangered species, land use and zoning, air quality, HTRW, coastal zone management, and transportation. Impacts to water resources, socioeconomics and environmental justice, cultural resources, recreation, visual resources, and noise were within the range of impacts documented in the FEIS and were determined to be 'de minimis'. There may be potential beneficial impacts to wildlife, as the reduced slope of the seawall allows for easier crossings by wildlife.

The proposed action results in a quantitatively larger impact to soils than in the FEIS, however, qualitatively the impact has not changed as the same soil types will be impacted by the wider seawall footprint. There is a net loss of 6.55 acres of wetlands due to construction of the project. However, a functional assessment was conducted and determined that there is a net gain of function units of both freshwater (+87.51 units) and tidal (+6.68 units) wetland habitats. No compensatory mitigation is necessary. Potential impacts of design changes are presented in tabular form in the Memorandum for Record.

Comprehensive Benefits Summary
The seawall alternative performs well across the four accounts. As evaluated in the SQRA, life safety consequences are reduced at least one order of magnitude with project. The +21.4 ft NAVD88 seawall maximizes net economic benefits, reduces the risks to life safety and would add over 19,000 FTE jobs to the county and over 30,000 jobs overall. Recommended changes to the seawall alternative have been evaluated for environmental quality and it has also been shown to have minimum impacts. The project will have beneficial impacts to all populations within the study area by providing storm protection and promoting resiliency to communities.

(12) Benefit to Cost Ratio.

This section provides the benefit cost ratios for the feasibility plan, and the updated plan, to demonstrate that the project remains economically justified. This section also provides a summary of the benefits and costs of the updated plan with a crest height of +19.4 ft NAVD88, and +21.4 ft NAVD88 to identify the scale of the project that maximizes net benefits. Benefits and costs for the authorized project and presented to Congress for the feasibility phase were annualized over a 50-year period of analysis at the then discount rate of 2.875% (FY17). The total annualized cost was estimated at $23,458,000 and annual storm risk management benefits were $30,374,000 (based on the historic rate of sea level change). Annual net benefits were $6,916,000 and the benefit-cost ratio (BCR) is 1.3. For the purposes of comparison, Table 24 presents the evaluation of the Director's Report project and the Validation recommended plan, using the updated still water elevations, at current price levels and current discount rate of 2.75%. The performance of the updated Validation project plan is shown at the low, intermediate and high rates of relative sea level change. Per ER 1100-2-8162, the BCRs are reported for all three RSLC scenarios, as directed. It should be noted that the latest observations indicate that the SSSI project area is tracking closer to between the intermediate and high scenarios of RSLC. Therefore, the intermediate scenario or the high scenario are the best indicators of expected economic performance.

Table 24 Benefit-Cost Ratios

	Director's Report Project +19.4 ft NAVD 88 (FY17, 2.875 discount rate)	Validation Report +19.4 ft NAVD 88[1] (FY24, 2.75% discount rate)	Validation Recommended Plan +21.4ft NAVD88 (FY24, 2.75% discount rate) Low Scenario	Validation Recommended Plan +21.4ft NAVD88 (FY24, 2.75% discount rate) Intermediate Scenario	Validation Recommended Plan +21.4ft NAVD88 (FY24, 2.75% discount rate) High Scenario
Annual Cost	$23,458,000	$34,090,000	$80,883,000	$80,883,000	$80,883,000
Annual Benefits	$30,374,000	$44,141,000	$67,491,000	$89,275,000	$204,583,000
Net Benefits	$6,916,000	$10,051,000	($13,392,000)	$8,392,000	$123,700,000
BCR	1.3	1.3	0.83	1.1	2.5

[2] Estimated using FEMA water elevations. Other columns are using the NACCS water elevations

[3] Cost for +21.4 ft NAVD88 DSP wall has contingency developed through CSRA. If the +19.4 ft NAVD88 DSP wall were refined through CSRA, the costs would be closer to what is shown for the +21.4 NAVD88 DSP wall.
[4] The high rate of SLC plots significantly higher than intermediate and low curves resulting in higher estimated damages.
[5] Per ER 1100-2-8162, the BCRs are reported for all three RSLC scenarios, as directed. However, it should be noted that the latest observations indicate that the SSSI project area is tracking closer to between the intermediate and high scenarios of RSLC. Therefore, the intermediate scenario or the high scenario are the best indicators of expected economic performance.

Economic Performance

The overall economic performance of the recommended 21.4 ft NAVD 88 height is presented in Table 25 for the project alignment plan as computed by HEC-FDA. Without project damages under the intermediate scenario of RSLC is $94,998,000 (rounded). With project damages amount to $17,815,000 and total inundation reduction benefits from the project is $77,182,000.

Table 25 Economic Performance- Coastal Storm Damage Reduction Only

Alternative	Equivalent Annual Damage			Probability that Damage Reduced Exceeds:		
	Without Project	With Project	Damage Reduced	75%	50%	25%
+21.4 ft. NAVD 88	$94,998,000	$17,815,000	$77,182,000	$58,138,000	$79,916,000	$97,214,000

Damages are presented for project alignment only and do not include boardwalk and interior drainage damage assessments.

Project Performance

ER 1105-2-101, "Risk Analysis for Flood Damage Reduction Studies (USACE, January 3, 2006) stipulates that the risk analysis for a flood protection project should quantify the performance of the plan and evaluate the residual risk, including the consequences of exceedance of the project's capacity. The guidance specifically stipulates, along with the basic economic performance of a project, the engineering performance of the project is to be reported in terms of:

- The annual exceedance probability
- The long-term risk of exceedance
- The conditional non-exceedance probability

The results from the HEC-FDA model were also used to calculate the long-term annual exceedance probability (AEP) and the conditional non-exceedance probability, or assurance, for various probability storm events. The model provided a target stage to assess project performance for each study area reach for the base year, 2032, and the last year in the 50-year period of analysis under both without-project and with-project conditions. For study area reaches without proposed levees or berms, the target stage was set by default at the elevation where the model calculated five percent residual damages for the 1% AEP (100-year) event. The HEC-FDA model calculated a target stage AEP with a median and expected value that reflected the likelihood that the target stages will be exceeded in a given year. The results show the long-term risk or the probability of the target stage being exceeded over 10-year, 30-year, and 50-year periods. Finally, the model results show the conditional non-exceedance probability or the likelihood that a target stage will not be exceeded by the 10% AEP (10 year), the 4% AEP (25-year), the 2% AEP (50-year), the 1% AEP (100-year), the 0.4% AEP (250-year), and the 0.2% AEP (500-year).

These indicators of project performance and reliability for the recommended plan are evaluated under the intermediate sea level rise scenario and presented in Table 26.

Table 26 Project Performance

Project Performance Analysis - Project alignment		
Annual Exceedance Probability of Target Stage	Median	0.63%
	Expected	0.98%
Long Term Exceedance Probability	10 Years	9%
	30 Years	26%
	50 Years	39%
Conditional Non-Exceedance Probability	10%	100%
	4%	100%
	2%	86%
	1%	62%
	0.40%	38%
	0.20%	13%

(13) Changes in Cost Allocation.

The project purpose is coastal storm risk management. No additional purposes have been added in this Validation Report. Accordingly, the cost allocation for this coastal storm risk management project is unchanged.

(14) Changes in Cost Apportionment.

The SSSI project is currently cost shared 65% federal and 35% non-federal. Based upon Section 8402 of WRDA 2022, costs that exceed the amounts contained in the 2019 PPA are to be cost-shared as 90% Federal and 10% non-Federal. The updated cash contributions required from the federal government and the non-federal sponsor are identified in the cost apportionment Table 27. Lands, easements, and relocations will be obtained by the non-federal sponsor and the costs for these activities are credited against the non-federal share, reducing the amount of cash contribution required.

Table 27 Cost Apportionment

	2016 PPA Cost Sharing (65% Fed, 35% non-Fed)	**Additional Costs Per WRDA 2022 (90% Fed, 10% non-Fed)**	**Recommended Plan FY24**
Federal Project Cost	**$399,900,000**	**$1,543,968,000**	**$1,943,868,150**
Non-Federal Project Cost	**$215,331,000**	**$171,552,000**	**$386,882,850**
LERRD's	$91,333,000		$185,123,495
Cash Contribution	$123,998,000		$201,759,355
Fully Funded (including sunk costs)	**$615,231,000**	**$1,715,520,000**	**$2,330,751,000**

Rounded to the nearest hundreds.

(15) Environmental Considerations in Recommended Changes.

The proposed design changes to the recommended plan described in this Validation Report remain consistent with the analysis of potential impacts to the environment documented in the 2016 Final Environmental Impact Statement (FEIS) and Record of Decision (ROD). USACE analyzed the effects of the design changes on the environmental resources in the project area. All impacts were determined to be within the range of impacts assessed in the FEIS. Per 40 CFR 1502.9(d)4, a supplemental NEPA document is not required. This environmental review is documented in a Memorandum for the Record (MFR) and is available as Appendix B of this report; a summary of this review is presented below.

Geology, Topography, and Soils. Construction of the proposed action would disturb approximately 276 acres (LOP: 82 acres; excavated ponds: 194 acres). This impact is quantitatively greater than in the FEIS, however, qualitatively the impact has not changed as the same soil types will be impacted by the wider seawall footprint.

Water Resources. Construction of the proposed action may result in an additional temporary, short-term increase of suspended sediments and turbidity in surrounding surface waters. The suspended sediments and turbidity are expected to settle quickly out of the water column, and therefore no long-term impacts to surface water quality are expected.

Vegetation and Wetlands. The proposed action will impact 207.09 acres of existing *Phragmites* monoculture low quality wetland habitat. Of this acreage, the impact of 23.71 acres is related to fill associated with the LOP and placement of hard structures in the interior drainage ponds resulting in a permanent loss of the existing wetlands. There are 157.47 acres of temporary impact associated with the interior drainage ponds and 17.64 acres of temporary impact associated with the construction of the tidal wetland/mosaic of habitat feature. An Evaluation of Planned Wetlands (EPW) functional assessment resulted in a net gain of +87.51 functional capacity units for freshwater wetlands and +6.68 functional capacity units for tidal wetlands. No compensatory mitigation is necessary, and the project maintains its self-mitigating status.

Wildlife. Construction of the proposed action would not result in additional impacts to wildlife in relation to the range of impacts assessed in the FEIS. There may be potential beneficial impacts associated with the flattened slopes of the project alignment, as it allows for easier crossing by local wildlife.

Threatened and Endangered Species. Construction of the proposed action would not result in additional impacts to threatened and endangered species in relation to the range of impacts assessed in the FEIS.

Socioeconomics and Environmental Justice. Construction of the proposed action would not result in additional impacts to socioeconomics or environmental justice communities in relation to the range of impacts assessed in the FEIS.

Cultural Resources. The proposed action would increase the risk to the Elm tree light and Hanger 38 due to the slight realignment of the seawall. However, construction of the proposed action would not result in additional adverse impacts to cultural resources from the range of impacts assessed in the FEIS. Coordination regarding minimization and/or mitigation of potential impacts is ongoing in accordance with the stipulations of the PA.

Land Use and Zoning. Construction of the proposed action would not result in additional impacts to land use and zoning in the project area in relation to the range of impacts assessed in the FEIS.

Recreation. Construction of the proposed action would not result in additional impacts to recreation in the project area in relation to the range of impacts assessed in the FEIS. There is a small increase in recreational areas due to the increased width of the promenade under the proposed action.

Aesthetics and Visual Resources. Construction of the levee under the proposed action would result in additional minor, short-term, temporary impacts to the viewshed as the levee settles to the design height. Once the levee has settled, there would be no additional impacts to viewshed in relation to the range of impacts assessed in the FEIS.

Coastal Zone Management. Construction of the proposed action would not result in additional impacts that were not captured in the previous coastal zone management consistency determination.

Hazardous, Toxic, and Radioactive Wastes. Construction of the proposed action would not result in additional impacts to HTRW in relation to the range of impacts assessed in the FEIS. The local sponsor will deliver the construction site free of HTRW materials and will cover any costs associated with the removal of hazardous material identified during construction. Any hazardous material would be removed and disposed of in accordance with all regulations.

Transportation. Construction of the proposed action would have short-term minor impacts to transportation and traffic. Access roads would only be utilized by maintenance and emergency vehicles and are not proposed for use by the public.

Air Quality. Construction of the proposed action would not have additional impacts to air quality in relation to the range of impacts assessed in the FEIS.

Noise. Construction of the proposed action would result in a short-term, moderate, temporary noise increase.

(16) Public Involvement.

Public information meetings were held during August 2015 as part of the public comment period on the Draft EIS, which was released in June 2015. The public meetings used a format that included an informal open house to allow two-way interaction between USACE representatives and the public. As part of the overall design process, there have been numerous meetings with the non-Federal Sponsor, and the local partner. There have also been periodic meetings with the regulatory agencies. As part of this process, coordination meetings were held with the local sponsor and stakeholders to discuss modifications to the seawall design and the basis for the recommendations. Public involvement has been limited to coordination with the NFS and local sponsor and has not included members of the general public.

(17) History of Project.

The SSSI project is in the PED phase and approaching construction of the first portion of the project. As the project is currently being validated through this Validation Report, a brief summary of the feasibility phase is provided, along with a summary of the ongoing efforts in the PED phase, which are proceeding independently from this Validation Report. This summary includes efforts underway by the Sponsor to remediate HTRW that impacts the project's western tie-in in Great Kills Park, and the City of New York's additional work efforts to the interior drainage plans of the project. The SSSI study was authorized by a resolution of the U.S. House of Representatives Committee on Public Works and Transportation and adopted May 13, 1993. Progress on the study was hindered by funding constraints until the study received funding to complete the study through the Disaster Relief Appropriations Act in response to Hurricane Sandy (P.L. 113-2). During Hurricane Sandy, 23 people in Staten Island died, with 10 of those direct drowning deaths occurring within the study area.[22] 14 of the 23 lives lost were due to storm surge. PL 113-2 funded studies were eligible for Director's Reports in order to access PL 113-2 construction funding, as long as the recommended plan did not include nourishment and there was enough funding within the program to construct the project. SSSI met both conditions when the study was concluded in

[22] https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6220a1.htm

2016, and the Director's Report was signed in December 2016. The Project Partnership Agreement was executed with the non-federal sponsor, the New York State Department of Environmental Conservation (NYSDEC) and the City of New York, a limited Party to the Agreement and a local sponsor to the NYSDEC, on February 15, 2019.

As described in the introduction to this Validation Report, the Director's Report described the intent of the authorized project to provide a project alignment as the first line of defense against severe coastal storm surge flooding and wave forces, and to reduce the risk of coastal storm damage with a still water elevation (tide plus storm surge) of +14.5 ft NAVD88 through a combination of buried rock seawall, levees, and tide gates. The +14.5 ft NAVD88 still water elevation correlated to a 0.33 % AEP under historic sea level conditions. To achieve this level of performance, the project was identified as needing crest elevations ranging between +17 ft NAVD88 to +19.4 ft NAVD88 to be within the acceptable range of overtopping (50 l/s/m). The study underwent all required agency reviews, and due to the complexity and cost of the proposed project, also went through Independent External Peer Review, per Section 2034 of WRDA 2007.

Key issues raised during the review of the Director's Report included:

- Use of FEMA stage frequency data for the feasibility study, as it was the best available data when the SSSI Sandy funded effort was initiated. Updates during design phase to using the USACE, North Atlantic Coast Comprehensive Study (NACCS) modeling efforts contained in the Coastal Hazard Library data could potentially change the design of the project
- The feasibility study team relied upon a Phase I analysis for hazardous, toxic, and radioactive conducted in 2005 for the SSSI study to complete the study, and planned to verify the phase 1 analysis during the PED phase
- The feasibility study team relied on 20 geotechnical borings from NYCDEP (1949-1966) and 14 borings (24-30 feet deep) conducted in 2002 for the study. Those samples detected some shallow clay layers, which were limited in distribution such that it was assumed at the time they could be effectively removed from under portions of the project and back filled with good material.
- Structure refinement for the buried rock seawall would take place as part of the value engineering phase for PED. At the time, it was identified that a concrete buried seawall could be an alternative to the buried rock seawall.

These issues were documented in the feasibility phase risk register as having the potential to affect the design of the project. With the initiation of the PED phase, the design team undertook field investigations (geotechnical and HTRW) and analyses to confirm and/or update conclusions from the feasibility phase. These analyses included a physical model and a semi-quantitative risk assessment, and also updates from using FEMA stage frequency data to NACCS Coastal Hazard Library data. These analyses led to the conclusion that the crest elevation needed to be increased by approximately two feet to meet the intent of the authorization (managing the risk of coastal storm damages associated with a 0.33% AEP water levels and waves under historic sea level conditions). Reviews during the design phase have been organized by construction contract, with the interior drainage features further along. District Quality Control is conducted at 30%, 60%, and 90% design milestones. Agency Technical Review is conducted at 60% and 90% milestones. IEPR is conducted at the 90% milestone. Table 28 shows the design progress of each contract to date.

Table 28 Design Status of SSSI Construction Contracts

SSSI Construction Contract	Current Design Status
Interior Drainage Area E (South Beach)	R60% (NYC additional work plan under preparation)

Interior Drainage Area C (New Creek, below Olympia Blvd)	R30% (NYC additional work plan under preparation)
Hylan Boulevard (Road Closure Gate, Levee)	R30%
Great Kills Park (Levee, Tide Gate, Interior Drainage Area A)	100% (subject to HTRW remediation by Sponsor)
Floodwall at Oakwood Beach Wastewater Treatment Plant	100% (subject to HTRW remediation by Sponsor)
Oakwood thru Miller Field (Seawall, tide gates, outfall gates, tidal wetlands, Interior Drainage Area B)	10%
Midland up to Fort Wadsworth (Seawall, Boardwalk, outfall gates, Interior Drainage Area D)	10%
Miller Field Offset	Preliminary design

Hazardous, Radioactive, and Toxic Waste (HTRW) Considerations

While the Director's Report was in preparation, it was identified that there was the potential for HTRW in the vicinity of Great Kills Park. At the time the feasibility study was completed, initial testing had been undertaken by USACE, under a Support Agreement via the Interagency and International Services (IIS) Program to the National Park Service (NPS), which identified the presence of HTRW, but without enough specificity to quantify the impact to the project alignment (specifically the levee alignment running along the eastern boundary of Great Kills Park). The Director's Report acknowledged the need for HTRW removal and identified that the cost would be borne in full by the non-Federal sponsor.

Subsequent to the Director's Report Approval, NPS advanced efforts to further characterize the contamination within the Great Kills Park and continued to contract with USACE via the IIS program to undertake these efforts. This additional testing, completed in 2017, identified the presence of HTRW along the footprint of the levee, and clearly identified that a HTRW removal action would be required along the footprint of the levee, prior to construction. In advancing the PED phase of the project, the non-Federal sponsor requested that USACE include the removal action of the site as part of the levee construction contract, as a non-Federally funded line item in the contract. Subsequent coordination and clarification were provided by HQUSACE that this approach was not acceptable, due to concerns including, but not limited to, liability to USACE when contracting these efforts. Direction was given to the non-Federal sponsor that as part of their non-Federal sponsor real estate requirements, they would be responsible for implementing the necessary response efforts and would be responsible for providing the project a clean site, prior to USACE constructing the levee.

To fulfill their non-Federal requirements, and given the prior involvement of NPS, New York City will be entering into an agreement with NPS[23] to design and implement the required response action. NPS, in

[23] *The National Park Service (NPS) has been delegated CERCLA response authority to respond to releases or threatened releases of hazardous substances on any facility under the jurisdiction, custody or control*

turn, will execute a Support Agreement with USACE via IIS for these efforts. Upon completion of HTRW response operations, New York State will provide written confirmation that the response action is complete and has achieved the stated clean site objective per ER 1165-2-132, Section 6(a)-(b) and ER 1105-2- 100, Appendix E).

Additional Work and Betterments

As the study has progressed into the PED Phase, there has been extensive coordination with the non-Federal partners for additional work to the project. These requests primarily relate to the interior drainage portions of the project. As per USACE policy and the terms of the Project Partnership Agreement, the MSC commander has approved the consideration of betterments to be conducted as part of the project, and an initial MOU has been entered into for the design and construction of these efforts within Interior Drainage Area E. Future additional work requests will require additional MOUs and must be funded in full by the non-Federal parties.

These additional work requests represent changes in the plan that do not reduce the level of performance of the project, but achieve additional objectives of the local sponsor, and allow for additional ponding areas. These design efforts are being undertaken by the local sponsor and are being reviewed by USACE as part of the standard review process. The sponsor is responsible for the design and review costs. The sponsor will also be responsible for all additional costs associated with construction of these features.

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of NPS. NPS is the lead CERCLA agency for this and other response actions taken or to be taken at the Site.

(18) Recommendations.

Several refinements to the NED plan alternative have been examined as part of the preconstruction design phase of the SSSI project in accordance with current Planning Guidance and the authorization outlined in P.L. 113-2. The recommended changes include transitioning from a buried rock seawall to a double sheet pile wall and the height is being increased from +19.4 ft NAVD88 to +21.4 ft NAVD88.The modifications are acceptable to the non-federal sponsor, agencies, and stakeholders as a Coastal Storm Risk Management Project.

I make this recommendation for construction of a double sheet pile wall, floodwall, and earthen levee to extend 5.3 miles from Fort Wadsworth to Oakwood Beach with a crest elevation of +21.4 ft NAVD88 to address flood events. This update, as well as the other changes outlined herein, meet the standards for engineering feasibility, economic justification, and environmental acceptability. The recommended changes will provide the authorized performance to reduce the risk of impacts to people and structures. This recommended project, which is subject to modifications by the Assistant Secretary of the Army-Civil Works, has a project first cost of $2,094,202,000 (including sunk costs at FY24 price levels) and a Total Project Cost (fully funded cost) of $2,330,751,000. In accordance with WRDA 2022 Sec 8402, the cost share between the federal government and the nonfederal sponsor is 90/10 respectively for all costs exceeding the 2016 Project Partnership Agreement. The total federal share is $1,943,868,000 and the total nonfederal share is $386,883,000.

Disclaimer

The recommendations contained herein reflect the information available at this time and current USACE policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of the national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to higher authority as proposals for authorization and/or implementation funding.

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Alexander L. Young
Colonel, U.S. Army
Commander and District Engineer

Reference Materials

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